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VGS
National

PROCEEDINGS

OF THE

NATIONAL ELECTRIC LIGHT ASSOCIATION

AT THE

THIRD SEMI-ANNUAL CONVENTION

HELD AT BOSTON, MASS.

August 6-7, 9, 10 and 11, 1887.

AND AT ITS

FOURTH ANNUAL CONVENTION

HELD AT PITTSBURGH, PA.

February 21, 22 and 23, 1888.

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A. J. DECAMP, ... Philadelphia, Pa.

SECRETARY AND TREASURER.

W. H. HARDING, ... Baltimore, Md.

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GEORGE S. BOWEN, . . . Elgin, Ill.
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J. F. NOONAN, ... Patterson, N. J.

CONVENTION

OF THE

National Electric Light Association

HELD AT BOSTON, MASS.,

August 9th, 10th and 11th, 1887.

MORNING SESSION.

The meeting was called to order at 10:30 A. M. on August 9th, by President Morrison, at the Parker House.

The President read the following address:

Gentlemen of the National Electric Light Association:

I have again to congratulate you upon the success of your organization, which the large attendance to-day from all over the country evidences.

Inventive ability, and irrepressible energy of the most pronounced character still farther encourages us in the belief that if electrical business does not achieve a phenomenal success, it shall not be for want of intellectual activity, energy and integrity.

Great progress has been made in the last six months in electric lighting generally, but especially in the development of incandescent systems. The induction system, which permits of low tension lamps, at a great

distance from the station, is a branch of lighting that has greatly increased since the last convention, and is now successfully conducted in numerous places. This system, more than any other formerly in use, is designed to find its place in the illumination of private houses. Its flexibility is very great. Its further development is encouraging.

Lighting by storage batteries has also received a great impetus within the last three months, and while there are still some difficulties to overcome in certain branches of illumination, it is fast superseding the dangerous oil lamp on railway trains.

Dynamos have been perfected, so as to give greater efficiency per pound of metal used, and our electricians are constantly working to reduce the cost of the machines, and thereby insure a large market for the same.

The perfection of the arc lamp has increased, and the demand for the same in the last six months exceeds the output of the previous eighteen months.

Mill owners, etc., are beginning to realize the enormous advantages of the electrical illuminant, not only in the more healthful condition of the operative, but also in the greatly decreased fire risks. The underwriters throughout the country recommend the introduction of incandescent lights to their patrons, in all factories where inflammatory fabrics are made.

Abroad the introduction of electrical installations has been slow and unsatisfactory, but of late our brethren across the ocean have taken up the subject with vigor, and to-day are becoming formidable rivals in the enterprising spirit of this country in the adoption of electric energy for all uses.

The Patent Office question, perplexing and unsatisfactory, as we are all aware it is, is now receiving attention through the agitation of the subject by this Association, which agitation we intend to keep up until Congress shall be compelled to furnish the needful legislation.

As suggestive of the multiplicity of uses to which electricity may be put, Lieut. Murdock submits a paper setting forth and explaining the electrical requirements for the new Government cruisers, and although this especial electrical application would necessarily be limited it will no doubt be useful, and still farther evidences the desire and demand for the applications of electrical devices in every branch of industry.

The perplexing wire gauge matter will again be placed before you, and if the work of the past six months, of the Committee on this subject, corresponds with the exhaustive and excellent report made at the last convention, we may expect something definite enough this time to decide the attitude of this Association in relation thereto.

I regret to have to announce the absence of a full report from the Committee on Insulation of Wire and the Proper Installation and Construction of Plant. This committee requested the Association to provide the necessary means to enable them to carry out their investigation. But, as the Association was in no condition to render them the pecuniary aid they required, they determined not to pursue their work any farther. I believe this to be a loss to the Association, as from the statements they have made of what they intended to do, if they only had the means. I can

easily foresee the loss of a great deal of valuable information to ourselves and to the world at large. A partial report setting forth the results of their investigations up to the point named will be presented to the Association in its proper place.

I have now the honor of introducing to this Association one of the most popular mayors that the City of Boston has ever had. A gentleman who represents public interests more than the interests of any particular party or clique, and who under the most trying circumstances has shown his fidelity as a public representative to such an extent as shall make his official administration one of the most memorable landmarks in the history of Boston's progress.

Gentlemen, I now have the pleasure of introducing Mayor O'Brien.

MAYOR O'BRIEN: Mr. President and gentlemen of the National Electric Light Association: You almost overcome me, Mr. President, by your very flattering remarks; but it gives the mayor of Boston great pleasure to welcome so many distinguished gentlemen to the city who are engaged in a very important work. I hope your visit will be a pleasant one, as also a profitable one, and if you can show us any way whereby we can light our streets and dwellings better than the work is now done, we shall be very thankful to you, Mr. President, and your Association.

I read in the paper a few weeks ago that immense fortunes were made in the electric lighting business. It must be a very attractive business, and I suppose now that I am addressing not only men engaged in electric lighting work, but millionaires of various degrees.

(Laughter.) Our experience in Boston does not, I am sorry to say, corroborate that fact. Electric lighting so far has been introduced by the energy, the ability and the intelligence of men who have been engaged in local lighting. I believe it is their intelligence that has scattered the electric light over the country in such large proportions in every city and many of the towns of the country. So far, I believe, profits have not been very equally divided. Some few men, I have no doubt, have grown rich in the electric lighting business; but I am satisfied that every man who has started a local company either in this city or in any other city of the country has been more a public benefactor than one who derived any pecuniary benefit from his work. I do not intend, gentlemen, to advise you or say anything about the work which you are engaged in. I have no doubt your discussions will be interesting and I hope that your visit to Boston will be a pleasant and agreeable one. I know it must be very satisfactory to many of you, coming from cities and towns where the thermometer ranges up to the hundreds, to visit so delightful a city as we have here in Boston where you can enjoy good fresh air at about 65. (Laughter.) And if you have time, it would give me pleasure to take you down our beautiful harbor and into our beautiful suburbs and I hope you will not leave Boston before you visit each of those places.

If you can give us any advise about the electric motor we should be very much obliged to you. We have got street car lines running in all directions and we would like to run them by electric motors, but the experience of electric lighting men in these parts shows

that experiments are very expensive, and we hope that some of you who are running electric railroad motors in other sections of the country will give us some intelligent advice on that subject. We also believe in the motor business here. Boston has neglected small industries. I believe if you establish a motor that will do the work that you will enable us to build up a great many small industries that have been neglected in the City of Boston.

I will not detain you any longer, gentlemen, but I again hope that your visit to Boston will be a pleasant one to you all. (Applause.)

THE PRESIDENT: The next business in order is the report of the Secretary and Treasurer.

The Secretary then read the following report:

REPORT OF SECRETARY AND TREASURER.

Balance in Bank, February, 1887.....	$200 00
RECEIPTS.	
From Feb. 21 to Aug. 1, for dues to the Association...	$1100 00
	$1300 00
DISBURSEMENTS.	
From Feb. 21 to Aug. 1, 1888.....	607 85
Balance on hand, Aug. 1.....	$692 15

The President then called for the report on legislation.

MR. STEUART: I have the honor to make the report of the Legal Committee as well as the report of the committee appointed at the February meeting in Philadelphia—a special committee on patent legislation. At that meeting I had the honor to read a paper upon the

necessary reforms in the patent system, particularly with reference to those reforms that were needed in the Patent Office, and I pointed out at that time numerous changes that were thought necessary in the Patent Office. The principal among them was the establishment in the Patent Office of a court that would embody in itself the jurisdiction that is now divided up among half a dozen different officers, all of whom are acting to a greater or less extent at cross purposes with one another. The second subject which was considered, was that of the increased calibre of the personnel of the office, and some systems were suggested. The third, was the increase of space in the Patent Office, and the establishment of a laboratory for the conduct of experiments, principally electrical, which are very much needed, and we had the pleasure of having a few words from Mr. Kintner, who was at that time the examiner-in-chief of the electrical division, since resigned, in which he set before you very clearly the very great needs of the office in that particular, there being absolutely no laboratory or any apparatus of any consequence—he said not over five hundred dollars' worth, in all—to test the inventions which are constantly increasing and which require to be tested in order to be understood.

Mr. Steuart then read the following report:

REPORT OF COMMITTEE ON PATENT LEGISLATION.

At the February meeting of this Association, your Legal Committee made a report in which were set out some of the present needs of the United States Patent

Office, and suggested a means by which the needs might be met and the defects remedied.

The subject being one of great importance, a special Committee upon Patent Legislation was appointed, consisting of Mr. J. F. Morrison, Mr. Walter C. Kerr, New York, Mr. Frank Ridlon, Mr. F. J. Sprague, Mr. Arthur Steuart, the Chairman of the Legal Committee, to further consider the questions presented, and make a full report to this Convention. Your committee has given the matter careful consideration and report that they are convinced that that branch of the Patent System which relates to the granting of patents, is based upon a law which was formulated at a time when the mass of business to which it was applicable was one-fiftieth part of what it is at present, and that the law needs revision in the following particulars among others:

1. The statute law of the United States relative to the granting of patents has very few provisions which determine the rights of applicants. The result is that nearly all the vital questions, both of law and fact, by which the rights of applicants for patents are to be determined, now lie within the jurisdiction of the various branches of the Patent Office. The examiners have nearly all questions of fact to determine, primarily, as well as many questions of law, and their jurisdiction is divided up among a number of junior examiners who are over burdened with work. The Examiner of Interferences sits as a court to determine the question of priority between contestants for patent on the same invention. From the Primary Examiners cases go on appeal to a board of Examiners-in-Chief and from them

to the Commissioner, and appeals from Examiner of Interferences go to the Commissioner. The personnel of the office is constantly changing, the Commissioners more often than others. Then, too, the persons who are appointed to the position of Commissioner, are generally chosen for some reason that has no connection with patent law, so that, as a general rule, the highest appelate tribunal knows less about the law and practice of the Patent Office, and the rules by which patent cases are to be decided, than the Examiner from whom the first appeal is taken. This being true, it is not surprising that the Examiners pay comparatively little respect to the decisions of the Commissioner, and also that one green Commissioner following another in quick succession should make rulings which result in a hopeless chaos in the practice. In addition to this fact the Commissioner is burdened with executive duties, which demand so much of his time, that with the greatest experience and power of work, it is impossible for him to properly consider the numerous important cases presented for his decision.

In order that the legal rights of patentees may be fully defined and secured, it is necessary that those rights should be understood and a settled method of obtaining them established; for this reason it is desirable that some means should be adopted to make clear and uniform the practice of the Patent Office.

All authorities seem to agree that the best method of accomplishing this result is to establish a strong court in the Patent Office, that shall have jurisdiction of all legal questions arising in relation to the issuance of patents as well as all questions of fact which arise in

interference proceedings; and on appeal from the Examiners.

2. The work required of the Examiners in the Patent Office is of such a technical nature and so important to the public that it seems to be desirable that the Patent Office should be put on the same footing as the Army and Navy. That the Examiners should be educated for the service; should receive compensation equal to positions corresponding to officers of the Army and Navy; should have the same system of admission and promotion upon examination and retirement on pay equal to that of those departments of the public service.

3. The Patent Office is now cramped for space, the employees are crowded into quarters half large enough for them, and the Patent Office building, built with money paid the Government by patentees, is more than half occupied by the Interior Department, which should have separate accommodations. Additional space would enable the Patent Office to have a laboratory so much needed, for the demonstration of electrical and other scientific discoveries and inventions.

To accomplish these reforms the most cautious, expeditious and at the same time intelligent way, seems to be the creation of a commission to be appointed by the President which shall carefully examine these and all other questions relative to the subject and report an Act to Congress which will provide for their solution. We suggest the following bill, which we propose shall be submitted to Congress this winter for passage.

A BILL CREATING A COMMISSION TO EXAMINE AND REPORT TO CONGRESS NEEDFUL REFORMS IN THE PATENT LAW.

WHEREAS, The Patent Laws of the United States are deemed to be in such a condition as to require revision, therefore,

Be it enacted, by the Senate and House of Representatives of the United States in Congress assembled:

Section 1. That a commission be, and the same is hereby created, to consist of three suitable persons, to be appointed by the President of the United States, who shall hold office until a final report of this commission is submitted to and accepted by Congress; and who shall receive for their service a compensation of $5,000 each per annum.

Sec. 2. It shall be the duty of this commission to examine thoroughly the present Patent Laws of the United States, and those of other countries, and their practical operation and effect in meeting the needs of the public and fulfilling the purposes for which they were created. To formulate a report to be submitted to Congress, which shall set forth the results of this investigation and their conclusions therefrom, with reference to changes in, or additions to, the present law pertaining to patents. This report shall also contain a draft of an act which will provide for the changes found necessary by the investigations of the commission.

Sec. 3. The commission is authorized to employ such clerical force as may be necessary for the proper conduct of its work, and to incur such other expenses for stationery, printing, &c., as may be found expedient.

Sec. 4. The salaries of the members of this com-

mission,well as all expenses legitimately as incident to its work, shall be paid from the surplus in the United States Treasury to the credit of the Patent Office. All expenditures by or for said commission, other than the salaries of the members, shall, however, be under the control of and authorized by the Secretary of the Interior.

And now a duty devolves upon the members of the Association. It is one thing for your committee to make this report, but a totally different thing to have it passed by Congress. That result can, however, be accomplished if the members of the Association will intelligently and faithfully support the hands of their Committee, by themselves, each one of them doing the part of the work assigned him to do. This Association represents twenty-four States, and members of this Association are fellow townsmen with eighty members of the House and Senate. While the members of the House and Senate from the States represented in the Association are 61 per cent. of all the members of Congress. The committee have divided up the members of Congress among you; and assigned to each the duty of seeing the members of Congress from his State and urging upon them the importance of the passage of this bill. Its passage lies in your hands. The present administration of the Patent Office has but one outcome. As the inability of the Patent Office to cope with the work of properly examining applications for patents increases, the respect paid by the courts and the public to patents will lessen, until all patents (and almost every dollar in the Electric Lighting business is invested under a patent) will come to be considered of no value

until they have passed through the rack and fire of a legal fight and obtained judicial construction. To avoid this contingency, your Committee feel sure that you will act promptly and effectively.

The Committee think it very desirable that the next meeting of the Association be held in the City of Washington. The location is central and Congress will be in session at that time. The members of Congress will have an opportunity of seeing how large and important an interest is calling upon them for action, and the members of the Association can take the opportunity of waiting upon their representatives in Congress and urging the passage of the bill we present for the appointment of the commission.

Respectfully submitted,

FRANK RIDLON.
J. F. MORRISON.
WALTER C. KERR.
J. F. SPRAGUE.
ARTHUR STEUART, *Chairman.*

Mr. Steuart then added: I have only one other word to say, and that is to sbumit the written report of the Legal Bureau, I shall not read it, it simply gives a statement of work being done by the Legal Bureau, of which I have the honor to be the custodian, in reference to a digest of the literature of electric lighting. We have at our command, at present, a set of journals and books which I suppose are not to be found anywhere in this country save in Baltimore, and we are now preparing an analytical digest of

the literature of the subject, which we feel sure will be useful to the Association.

MR. RIDLON: I wish to offer the following resolution in regard to this report:

Resolved, That the report of the Committee on Patent Legislation be accepted, and the committee continued and authorized to take such steps, not involving expense to the Association, that they may find necessary, to have this bill as presented passed by Congress.

The resolution was seconded by Mr. Lynch and adopted.

THE PRESIDENT: The report of the Committee on Revision of the Constitution will be presented by Mr. DeCamp.

MR. DECAMP: In looking over the reports of the various meetings it appears that there have been several amendments made to the constitution which we have printed that change it entirely. Therefore we have thought fit to submit an entirely new constitution as a substitute for that which was originally adopted, and I now lay it before you.

The Secretary then read the report of the Committee on Revision of the Constitution.

REPORT OF COMMITTEE ON CONSTITUTIONAL REVISION.

I.

The name of this Association shall be "The National Electric Light Association."

II.

Members of this Association shall be companies, firms or persons operating Electric Light and Power stations for public or commercial purposes, manufacturers of electrical supplies and apparatus. Electri-

cians, Electrical Engineers and persons, firms or companies whose professions or business is directly collateral thereto, may become members upon the recommendation of the Ex-Committee and approved by the Association.

Each member in a vote by ballot shall be entitled to one vote.

A ballot may be demanded by one-fourth of members present.

Persons may become honorary members, without the right to vote, by ballot of the Association.

III.

The officers of this Association shall be a President, two Vice-Presidents, Treasurer and Secretary, and an Executive Committee of six members, the President, Vice-Presidents, Treasurer and Secretary being members *ex-officio*.

IV.

The President and Vice-Presidents shall be elected by ballot to serve from the close of the annual meeting at which they are elected until the close of the next annual meeting.

The Treasurer and Secretary, who may be one and the same person, shall be nominated by the President, subject to the approval of Executive Committee. The Executive Committee shall be chosen by ballot at each meeting, either annual, semi-annual or special, to hold office from the close of the meeting at which they are elected until the end of the meeting at which their successors are chosen.

V.

The duties of the several officers shall be those usually pertaining to their respective offices.

The Treasurer, Secretary and Executive Committee shall make a written report at each meeting to be spread upon the records of the Association.

VI.

The Executive Committee shall be the governing body of the Association, three of which shall constitute a quorum. They shall meet from time to time and shall report upon application for membership, gather and prepare information upon topics of interest and arrange for their discussion at the several meetings of the Association.

VII.

The annual meeting of the Association shall be held in February, and the semi-annual in August of each year, at such place as the Association shall determine, and such date as may be determined by the Executive Committee.

VIII.

The membership fee of each member shall be $10, which shall accompany the application.

The annual dues shall be $10, payable in advance, and shall cover the calendar year.

IX.

All amendments to the Constitution shall be presented in writing and referred to a committee to be appointed by the Chair before being acted upon by the Association. A two-thirds vote of those present shall be necessary to their adoption.

A ballot on each amendment may be called for upon the request of five members of the Association.

THE PRESIDENT: Gentlemen, the report of the committee is before you. What disposition will you make of it?

MR. LYNCH: I move that it be accepted.

The motion was seconded.

MR. DECAMP: There is one thing which occurred to my mind there in the reading of that report which is an error; that is in the part that refers to the treasurer, which should read: "May be one and the same person."

MR. LEGGETT: I would like to inquire what is the meaning of the clause relative to the annual dues. Suppose a company should organize at the present time, would they have to pay up their annual dues from the time of the organization until the time they enter, or do they start from the time they apply?

THE PRESIDENT: They start from the time they apply. If they join on the last day of the calendar year, according to this, they would be compelled to pay their membership fee and dues, being twenty dollars; thereafter ten dollars a year, and the ten dollars will cover the calendar year.

MR. LEGGETT: Is that expressed in the Constitution as read there?

THE PRESIDENT: Yes, sir.

MR. LEGGETT: I did not so understand it. I would ike to have that clause read again, please.

THE PRESIDENT: I think the better way is to take up the whole paper *seriatim*. Will some gentlemen make a motion to that effect?

A motion to this effect was made and carried.

THE PRESIDENT: If there be no objection to the sections as they are read, they will be considered as approved.

The Secretary read the first and second articles.

MR. GARRATT: I move that the number three in section 2 be changed to four.

MR. PHELPS: What is the object of that amendment?

MR. GARRATT: My object is this: Oftentimes manufacturing companies find it necessary to send several gentlemen to these conventions to properly take care of their exhibits and their business. Somebody, in that event, of the number will have to be left out of the Association. I see no element of danger to the Association in having four men pulling on one rope in this convention. If there is any, I should like to have it stated because it is an important question. I think, however, there will be many concerns and are many at present who would like to make four men members of this Association, not so much for the purpose of their votes as for the purpose of having the men inside of the Association. I think five would be a little too many and I think three a little too few.

Mr. Garratt's amendment was adopted.

MR. DUNCAN: I would like to inquire what is meant by supplies; what does representatives of supplies mean there.

THE PRESIDENT: It means wire, carbons—all the materials that enter into the making up of a plant.

MR. DUNCAN: It is a very ambiguous clause, it seems to me.

THE PRESIDENT: It makes it all the more elastic. I presume that was the intention—to make it elastic, so that all those engaged in business who desire to become connected with the Association could reach it in some way.

The Secretary read the remainder of the amended Constitution.

MR. SMITH (Allegheny County Light Co.): I should like to ask in reference to the section which speaks about the members, if that is intended to include oil men and people who furnish supplies of that kind; because if the object is to make it as elastic as possible, we better throw out the word electric lighting, as that might scare off some people who would like to be members. It seems to me that if this is an Electric Light Association we ought to draw the line somewhere.

MR. DUNCAN: I move, sir, to recommit that report to the committee for the reason that in the first place they were not authorized to prepare a new Constitution. They were simply authorized to prepare such amendments as they might see fit to incorporate. In the next place it takes a two-thirds vote of this Association to adopt an amendment. In the next place they have changed the Constitution to such an extent as to center the whole power of this organization in the President—not that I have any objection to the *personnel* of the President, whatever, but I have an objection to the centralization of power. It says in this new Constitution that the Secretary and Treasurer may be one man and in another section that that one man may be removed at the will of the President. It seems this Association can arrange those officers in such a way as not to place the organization in a position of that kind, and for those three reasons I move to recommit that report.

The motion was seconded by several members.

MR. MORRISON: (Vice-President Weeks in the chair.) The principal objection which Mr. Duncan

refers to seems to me to be the centralization of power. There seems, however, to have been no objection to the centralization of labor. (Laughter.) The work of this Association has been done in the main by the people who are brought immediately in contact with the President. That part of the work which is left outside of that has generally been left undone, except in two notable cases—Mr. DeCamp and Mr. Gilbert. It is impossible to appoint a Secretary of this Association in Chicago, and a President in Baltimore, and a Treasurer in Boston, and have the business transacted in such a way as will be satisfactory to the Association. At your Detroit meeting I was very anxious to be relieved of the duties of president of the National Electric Light Association and those of you who were present at that meeting —I was not present myself and had telegraphed my resignation— those of you who were present at that meeting are fully aware of the steps then taken to bring about this exact condition of things. This report I presume was gotten up hurriedly and there are other and graver objections to my mind than that of the centralization of power. What you want in the government of an Association of this sort—before I leave that question—is the centralization of power, so far as you can trust the men in whose hands you place it. A scattered, diffusive authority in an Association of this kind will result in the death of the Association in about twelve months. It requires rather strong government to hold together such an Association as this and if divested of the supply and the oil men that Mr. Smith refers to, you would not have

enough money contributed by men actually engaged in the electric lighting business to pay the rent of this hall two weeks. There are all these elements entering into the general make-up of the National Electric Light Association and it is only by a strong, closely governed arrangement that you can hold your people together and bring about the condition of things which we are all striving for which is the dissemination of information in our line.

The sixth article, which says that the annual meeting and the semi-annual meeting shall be held at such places as the Executive Committee shall determine, I object to. In my judgment the place of meeting of the National Electric Light Asssciation should be determined by all its members in council, and not by the Executive Committee. I believe, and I think it is the general impression, that almost any city of this country will be proud to have this Association meet within its limits. Mr. Steuart in his very able paper on another subject has called your attention to the fact that twenty six states are represented in the National Electric Light Association. With that broad representation I should say that the designation of a place at which your various meetings shall be held ought to be done in the body of the convention.

Article seven is not sufficiently distinct; the case is not clearly enough stated. The entrance fee shall be ten dollars for each member; the annual dues shall be ten dollars, payable in advance, and shall cover the calendar year. I should put it in somewhat plainer language. I am not yet prepared to suggest any amendment. The fact that the Constitution prescribes

a line of duty for the President and all the other officers, brings their conduct directly under the hand of this convention. As to the objection that this is a substitute for the Constitution laid before the committee, I would say that the substitute may be adopted as an amendment to the original Constitution by that vote which Mr. Duncan speaks of; that is, a two-thirds vote of the members present.

MR. COOPER: I would amend the proposition to refer back to the committee to this extent, that they report at some other meeting of this session——

MR. DUNCAN: I wanted to call the attention of the convention to the incongruity of that report; I simply wanted to raise the question.

MR. COOPER: I thoroughly agree with Mr. Morrison in the idea of centralization, because it is very inconvenient to send the bills to Baltimore and send them back to Brooklyn, and have them approved by the committee and the checks sent from Brooklyn. I think it should be all under one head. I thoroughly agree with that, because it is simply having a position, without anything to do, for the treasurer to be in one city with the rest of the officers, and the business conducted in another. I will say for myself that I agree with the report to that extent and hope it will be carried.

THE CHAIRMAN: It is moved and seconded that the report of the committee be re-committed with instructions to report at some later session of this convention.

The motion was carried.

Mr. Morrison resumed the chair.

THE PRESIDENT: I desire to add Mr. Duncan to

that Committee on By-Laws. Mr. Duncan, will you serve with the Committee on By-Laws?

MR. DUNCAN: I will give them the benefit of my assistance.

MR. SMITH: (Allegheny County Light Co.) I would like to make an explanation. My object in speaking of the oil men was not to exclude them from the Association; but I think as I understand—I may be wrong as I am only a new member here — that this Association is especially for the benefit of those who put their money into Electric Light Companies and that the great object of this Association was to enable them to swap experiences and so on, and while in that case although it is a very great advantage to have oil men and every one of that kind present, it seems to me there is a little danger of being outvoted on our own ground some day. It seems to me there might be some arrangement made by which we could have full members with voting power and others who have the rights and benefits of full members with the one exception of the voting power.

MR. LEGGETT: Is a motion in order at this stage?

THE PRESIDENT: We are on reports now of committees. (Handing a copy of the old constitution to Mr. Smith) That will show you just how we stand. The report of the committees on wire guage will be presented by Mr. Garratt.

MR. LEGGETT: I would like to say, if I am in order at this stage, that a year ago I had a conversation with our chairman in Baltimore, and he expressed to me at that time an opinion to the effect that he thought it was desirable that the officers of this Association, especially

the President, should be rotated for various reasons, one reason as I recollect particularly, was, that when——

THE PRESIDENT: Will Mr. Leggett give me an idea of the drift of his remarks?

MR. LEGGETT: I want to make a suggestion to go to the committee just appointed.

THE PRESIDENT: Just make that to the Chairman of the Committee, please.

MR. LEGGETT: I have no objection.

THE PRESIDENT: The Committee on Wire Gauge—Mr. Garratt.

REPORT OF WIRE GAUGE COMMITTEE.

MR. GARRATT then made the following remarks: Mr. President and members of the National Electric Light Association: A year ago in Detroit a committee was appointed to consider the matter of wire gauge, which at that time was in an almost hopeless condition. After six months of constant correspondence with the largest users and makers of wire in this country and abroad, and the leading scientists in the specialty of electricity, I reported at Philadelphia that this Association do two things — first, that it vote that the British standard gauge be no longer the recognized gauge of this Association, and secondly, that the metric system be made the basis of measuring wire. Both of those motions — or they were incorporated in one motion, one resolution — were accepted. The honor conferred upon me in accepting my report was not less than the honor I received in being again placed at the head of the committee to elaborate this subject. The

committee was considerably increased by the addition of some valuable members. During the six months we have taken the subject of measuring wire in simple diameter in the tenth of a millimeter and have elaborated it into a mathematical table. The table is not of necessity a gauge, although the first column to the left represents a series of even numbers—integral numbers, which agree with the tenths of millimeters which appear in the next column or column No. 2. The object of doing that is this—in sending telegraphic messages I find it is almost impossible to make a telegraph operator use a decimal point. It is almost impossible also in hasty writing to always get the decimal point in the right place. For common purposes, in speaking of wires in ordinary business parlance, a simple number is more convenient than a number with a decimal point; for this reason a column of figures is here placed with simply that decimal point removed. That, however, is not the gauge, if there is any gauge. The gauge, if there be one, is simply the measuring of wires in diameter in tenths of a millimeter. That appears in column 2. As we have in this country a unit which is much more familiar—the inch—it seemed wise to this committee to convert those diameters into inches for the purpose of referring to tables which are already constructed, and with which many electricians are thoroughly familiar. For that reason, table No. 2 was multiplied by a constant which represents tenths of millimeters in the denomination of inches. It was multiplied simply by the number 0.039371. That converts the tenths of millimeters into inches, so that, though unfamiliar with the metrical properties of wires, you can readily

refer to these tables and see just what they are in thousandths of an inch. An electrician looks upon a wire not as a wire as we ordinarily express it, but as a cylinder, and the properties of wires are based upon the properties of cylinders. There are three properties of wires which enter into the work with which we have to do,—the tensile strength of the wire—that I shall not touch upon; it is a subject by itself and does not directly interest us now. The static capacity of wires,—that I shall not touch upon, because in electric lighting wires it is entirely a neglectable quantity in the present state of the art. The third property is the conductivity, and it is necessary for us to know the ratios of conductivity to weight, to size in diameter, and to length of conductor.

The first thing we want to know about a cylinder to determine its physical properties is its sectional area. In this particular table, to insure almost absolute accuracy, the mathematical work was done independently by two members of the committee. Mr. P. Keilholtz, of Baltimore, independently calculated tables 4 and 5, which you see here. Mr. Herbert H. Eustis calculated the same tables. They were submitted to me. I compared them and found some differences. Where differences occurred I independently made two calculations upon different days, and if those two calculations agreed I submitted them to the other gentlemen, and the alteration was made in their calculation. Virtually, then, these columns 4 and 5 have been independently calculated by three persons. The likelihood of error has been reduced to a minimum by not calculating it by ordinary arithmetic, but by

calculating it in logarithms, and the logarithm table used in fine astronomical calculations was the one employed—the seven place logarithm tables compiled by Vega. In that calculation comes in the property of the *phi*-ratio. This sectional area was calculated by these two gentlemen from different formulæ. Mr. Eustis calculated it from the square of the radius of the cylinder multiplied by *phi*. Mr. Keilholtz calculated it by this formula (illustrating) — the square of the diameter multiplied by *phi* and divided by 4, two entirely independent calculations. Probably the tables here of area in square millimeters and square inches are about as correct as it is possible to make a table of figures. The calculation into the square inch, of course, was an independent calculation bringing in the ratio which we already have between the inch and the square millimeter.

Before I go on to the other details I will say here why we put this question of sectional area so conspiciously on this table and so near the beginning. The properties of conductivity of wires are directly proportional to the sectional area. I wish to refer back one moment. This figure here 3.14159—the *phi*-ratio—is one which has never been written out. There is another number after this nine and another after that. A distinguished French mathematician has carried that to two hundred and fifty places of decimals and there are others beyond that.

These tables of area are based upon the value of *phi* given above.

The conductivities of wire are proportial to sectional area. They are, however, proportial to another property

of cylinders which is entirely independent of the *phi* ratio and which is extremely simple in practical use. The conductivities of wires are directly proportional to the squares of their diameters. You will find away over here in column No. 16, squares of diameters. Wires have to be used by a great many men who are too hurried in life to familiarize themselves with mathematics and with electrical formulæ, and who want to get quickly at what wires may be expected to do. From this simple table, No. 16, by simple arithmetic, you can arrive at almost any physical or electrical property of the cylinder or of the wire which is a cylinder. For instance, if I have a small wire or if I have twenty small wires and I wanted to have a large wire of the same conductivity I would simply have to take that square of diameter multiplied by twenty and look in the table and find the nearest corresponding numbers in this column, No. 16, and I would have the wire which would give the same conductivity. In problems involved in the work which linemen are obliged to do, who do not care to go into these matters at all, they have in such a table necessary data for determining nearly everything which they would be required to know.

I do not think I will now go into determining the constants which were used, for it is a long mathematical work. I will say, however, that they were figured independently by two members of the committee. The units were taken from Matthiessen's last determination—of the British Association unit—multiplied by the constant which converts that resistance into the legal ohm. Hence that resistance and also the physical properties relating to resistance, such as feet per ohm

and pounds per ohm, correspond to the data used in modern scientific works.

Many gentlemen will take exception to the fact that this is calculated at zero centigrade. This convention, if it sends out this circular, has got to commit itself to the scientific world as having done a thing which no trade body in the United States has heretofore done. It is a scientific matter. It will be studied and criticised. These calculations will be gone over by scientists and mathematicians. Zero centigrade is now recognized the world over as the unit of Temperature. There is no probability that in the immediate future it will be changed at all. I have corresponded with leading professional electricians in this country, and without a single exception they replied to me—by all means determine your gauge on zero centigrade. Every electrician is familiar with the simple constant which is .0038; by multiplying the number of degrees centigrade by this number you will get a number which multiplied by the resistance at zero centigrade will give you the resistance at any temperature. But the zero centigrade is that on which all scientific work is based when the question of temperature is involved.

The question of making these determinations of resistance, etc., on commercial copper or on pure copper, the committee found it utterly impossible to determine what commercial copper was; hence, this table has been calculated upon the basis of chemically pure copper. If those manufacturers who adopt and use this gauge will append a constant at the bottom of their table, which you can multiply into any one of these properties and convert your resist-

ance, directly into the degree of purity which they claim to put out commercially, it will give their customers the information they want, and this Association will have a thing which can be used as a standard all over the country, and for that reason chemically pure copper was taken.

There are two other tables here which may not be of much interest, but which this committee has seen fit to tabulate, to enable electricians generally to make calculations of this gauge in fine electrical work; that is a table of logarithms of area. We have appended seven place logarithms which have been calculated by three members of the committee—a logarithm of the square millimeter and a logarithm of the square inch of each independent size of wire. That, of course, is not a commercial figure; I don't know that it will ever appear in a trade circular, but it is valuable for us to use and put out for electricians to use.

Last of all, and to get our minds familiar with an unfamiliar thing—and here I must say that of course it will be impossible to take up any new thing, no matter what its value may be, without putting ourselves to considerable work—no man here could take up this metric gauge and work with it on five minutes' notice. He would not, however, work at it five minutes without discovering that he was using much fewer figures than would otherwise be necessary.

Tables 17 and 18 are the numbers nearest corresponding with the Birmingham and Brown & Sharpe gauges. The Brown & Sharpe gauge I have taken from a manuscript copy sent to a member of this committee (Mr. Eustis) by Messrs. Brown & Sharpe, and I will say here that of

the wire drawers who publish Brown & Sharpe tables —very few of them agree as to the actual size of Brown & Sharpe numbers. I examined one table in which, out of forty numbers of Brown & Sharpe, twenty-eight were wrong, and that was from one of the best wire makers in this country—that is, they did not agree with Brown & Sharpe's own statement in regard to their particular gauge; this fact may surprise some, but it is nevertheless true.

In regard to the Birmingham gauge I will say there are fourteen independent Birmingham gauges in use at the present time. I have taken Mr. Gordon's figures in regard to the size of the Birmingham gauge, for the purpose of comparing it with the metric. Mr. Gordon has spent a great deal of time upon the question of the physical and electrical properties of wires. Among other things, he has compiled the largest tables on the properties of wires which have ever been published, expressed in the old ohm. I have taken his sizes of Birmingham to compare with the gauge.

I will not further bother you with these figures. Of course this committee has been very glad to do this work. All of the work other than the first five columns has been calculated by Mr. Eustis and myself. It has occupied every evening for three or four weeks until past midnight most of the time. We have put our best work and energy into it. We have based it on the best information that we could get inside and outside of this Association, and we have not failed to consult with any one from whom we could get assistance. We have corresponded with the Smithsonian Institute at Washington, and although they were unable

to give us any direct aid, for want of apparatus, they gave us the assurance that the result of the deliberations of this assembly should receive proper recognition before the government of the United States, and if, in their opinion, it was wise, it would be adopted as the governmental measure of wire of the United States. I will say here that by act of Congress the metric system is already the legal system of measuring of the United States government. It is used in many of the departments. Every scientist works in it, and it is simply a question of time, no matter whether we adopt this particular gauge or whether we discard it as useless— it is simply a question of time when the properties of everthing that can be measured will be determined in the metric system. We have it now in this form. It is useless for any body of men to attempt to legislate what other men shall do. It is useless for a body of men to attempt to legislate what they shall themselves do. If this Association should vote to adopt and use any gauge they never would be able to enforce it among their members unless those members found it for their advantage so to do. Personally, I do not anticipate that everybody is going to lay aside thousandths of an inch, the Brown & Sharpe gauge and the Birmingham gauge, and immediately take this up. I know, however, it is only a question of time when some such system of measuring will be used, that will do away with all arbitrary numbers which in themselves convey no idea as to the quality which you are expressing.

The question of bringing this commercially before this country is a grave one, and one to which I have

not given the attention that I have given to the mathematical part of this question. Of course I have corresponded with all of the wire makers in regard to it, and at the last convention I read a voluminous correspondence from them, the majority approving of this and hoping that it would be carried out.

I propose this afternoon to have this table electrotyped. It will then be the property of the Association in electrotype. It can then be cut up and such portions of it furnished to manufacturers as is thought fit. This gauge goes from the tenth of one millimeter to ten millimeters, which means from about a 38 wire to a No. 00, or No. 000 wire. In some portions of the gauge it gives a much finer division than either of the others (Brown & Sharpe and Birmingham); in other portions it does not give near as fine a division. In the portion of gauge which would be used it incandescent wiring, it gives much finer properties; for example, in No. 12 there are five wires in this gauge inside of the dimension of No. 12 wire, and electricians are getting to work finer and finer on the properties of their wires all the time. It is a tendency of the times to do so. As you go up into the larger wires it becomes very marked. In the larger portions of this gauge there are 7, 8 or 9 numbers instead of the single number of Brown & Sharpe, or the Birmingham gauge. I have received a number of letters from well-meaning persons calling attention to the fact that in the small portion of this gauge there is too great a variation between the numbers. That is very true, but nobody can tell just what size of wire anybody wants in these small sizes. To tabulale it would be to make a book as big as the dictionary, but from the

figures given any electrician can calculate the electrical and physical properties of any wire varying in hundreths of a millimeter. All of the data is here, necessary for making such computations. I presume in these fine wires, if this system is adopted, you will find in the course of a short time that manufacturers will b. publishing odd numbers; instead of No. 2 gauge i. might be 2.23 which might meet the particular require- ments of somebody, or some class of customers. Those first ten members will probably undergo con- siderable alteration. The table which your committee has prepared will be the basis for determining their physical and electrical properties. Take it in the use of expensive wires—in platinum, for example, no man drawing expensive wires can afford to adhere to any particular gauge, because the requirements are so nice in regard to it; but from the data you have here there is no difficulty in any one determining just what the resistance will be or the size shall be, or the weight of any wire he wants determined in terms of a hundredth of a millimeter, which is about three times as small a difference as you find in the thousandth of an inch.

I don't know that I have anything more to say. I suppose I have made myself extremely disageeable to a great many people. I have troubled a great many people in regard to it. I have called in the best expert testimony which I have been able to get in this country. I have worked some of the members of the committee night and day. I have put the matter in type. I lay the matter before the Association. What will you do with it, gentlemen? (Applause).

Mr. Eustis: I would mention that in the hurry of

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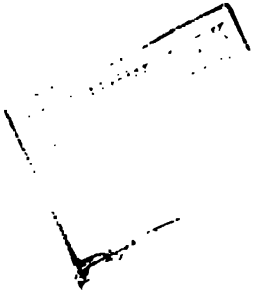

writing those figures down on the blackboard, Mr. Garratt omitted to put in a 3 in the first one, which should be 039371. But in order to give the Association some little idea of the work that has been undertaken by the committee in tabulating this gauge, I would mention that on a rough estimate of the number of figures necessary to calculate, it comes out in the neighborhood of 30,000 — probably rather more than less; that is, for each separate calculation. Now, as the whole thing has been done three times, it would make a nice little figure, very close toward a round 100,000.

MR. MAILLOUX: A few friends of mine I see beginning to smile as I get up to say something on the wire gauge question, and probably what makes them smile is the remarkable slowness with which we have been arriving at any sort of conclusion relative to any wire gauge. The committee of the American Institute of Electrical Engineers has had the subject of wire gauge under consideration for a long time—it must be two or three years. There has been more or less interest taken in it by the members of the committee, and efforts to arrive at the determination on what is proper and right in wire gauge. I was very much interested, as being a member of another committee (Society of Electrical Engineers) to report upon this subject, and I think that we should appreciate the care, the precision and the assiduity with which Mr. Garratt and this committee have carried on their work. But at the same time I feel that I must emphasize a point which he himself has alluded to. I am brought to this consideration by remembering that, while a gauge may be particularly suited to the

requirements of one individual, or set of individuals, yet it is of the utmost importance that a gauge, in order to become universal, should have the elements of usefulness to all parties who are using gauges. I notice that between the size corresponding to No. 38 of Brown & Sharpe gauge and No. 32 he has only one number; there is only a difference of a tenth of a millimeter. Now, those who are in the telegraph business and the telephone business, and many other cognate industries would see at once a very grave objection. It is true, as Mr. Garratt proposes, that we may have several sizes—smaller sizes in tenths of a tenth of a millimeter; but if we begin to introduce the subdivision of the scale, it seems to me that we might just as well have no scale at all, and revert to the principle of determining the diameter by the thickness in the first place, irrespective of any number, or of any gauge, for that matter. As you all know, it is a common practice in this country, and there seems to be a large preponderance of sentiment in favor of determining the size of wire by thousandths of an inch. The difference in the use of systems of measurements is one which has full weight, of course. At the same time we must not forget that in this country we are, so to speak, married to the old system of gauge, and that there is only a very small proportion of the people who really understand the system or could use it intelligently; and, therefore, it looks to me that, while the system is very well adapted, indeed, to the requirements of the electric light industry, insomuch as it affords a long range of sizes differing from each other by very much smaller differences than the gauge at present in use; yet, as we get to the

other end of the scale, it is not so far deficient as it was advantageous at the former end. If wire makers throughout the country were to adopt the system of gauge and draw their wire in accordance therewith then if a telegrapher or telephonist wanted to rewind a magnet that was 38 and wanted the next size larger he would have to use what would correspond to No. 32, and I find that the resistance per given length varies in the ratio of four; whereas, by the present system we have a ratio which varies by less than only a little over 90 per cent.

After due consideration of all these points, our committee, which comprises in its body a celebrated engineer, a man who is connected with the United States army in the engineering corps, a very skillful mathematician, has come to the conclusion that no system of gauge in which the sizes are defined by equal increments of diameter can ever hope to meet the requirements of the general body of electrical industry, and if we look into the matter closely, we shall find that the gauges at present in use have after all a great deal of convenience, and that the gauge which would be based on the same principle would at least be entitled to some consideration before we vote to adopt definitely and inflict upon the community one more of the numerous wire gauges. I say inflict, not because I wish to disparage the very fine work that has been done by your committee, but because to add another official gauge to the number already existing would be to increase the perplexity with which we are now so greatly troubled in trying to make calculations regarding wire.

The basis, I think, of a proper gauge would be an

asymptotic one—a gauge in which the sizes of wire vary with the resistance or the sectional area as a function, as a variable quantity, so that the ratio would be represented by a curve, which is hyperbolical, somewhat nearly like the curve of the present Brown & Sharpe gauge. I think it would be proper to modify these gauges by introducing some intermediate sizes. In that case, as it will readily appear, it would be possible to represent all the numbers of gauges by formulæ, so that knowing one gauge or the diameter of a gauge, an electrician or a mathematician could easily calculate all the others, and derive all the properties belonging to the others, and if he were using formulæ he could introduce the formulæ itself and in that way arrive at the properties of all others by the usual method of elimination of quantities.

MR. GARRATT: Will the gentleman kindly give an example in gauge calculation which an unintelligent man could make on the Brown & Sharpe gauge or the Birmingham gauge, which he could not make by measuring wire by the diameters in tenths of a millimeter? The gentleman made the statement that the metrical system was unfamiliar to the general run of people and therefore they could not use it with the facility with which they could use the Brown & Sharpe gauge. Will he kindly give me such an example, or will he state one on the blackboard himself?

MR. MAILLOUX: I think I should state that you find in practice that the electricians or the men that Mr. Garratt refers to, the linemen, would not go to the trouble of multiplying, because a great many of them could not multiply two quantities of two figures each.

MR. GARRATT: You said they could make the calculation more easily with Brown & Sharpe's gauge than they could with the metric system.

MR. MAILLOUX: I did not intend to say so.

MR. GARRATT: Then I misunderstood you, sir, and you did not say it.

There is one other thing. The gentleman said it would be good to have the gauge on the same principle as those now in use. Will he be kind enough to state the principle on which present gauges are made?

MR. MAILLOUX: The Brown & Sharpe gauge is the only one which may be said to have any principle at all in it. The others are a merely arbitrary form of gauge which has come from long usage and custom with reference to convenience, and when I speak of the objections to a gauge, I do not refer to the electrical features of the gauge only, because I believe that a gauge which can have any hope of being universal must be applicable to other requirements besides those of electricians. It is a custom in measuring sheets of metal and various other things in commerce, to measure by sizes like that, and I think it would be doubtful—it is doubtful in my mind if a system of that kind could be made applicable to those uses. Now the basis of the Brown & Sharpe gauge can be represented by drawing a triangle having a certain definite length and a certain base.

MR. GARRATT: Shall I state the dimensions of the triangle for you? Will you please give them to me that I may place them on the blackboard.

MR. MAILLOUX: I do not know the figures at present. I know it can be represented by a curve

which is more or less accurate. The trouble with the Brown & Sharpe gauge is that the ratios are not uniform, but they could be made so, and I think it would be possible to construct a gauge having an asymptotic curve as a basis which would be thoroughly scientific and satisfactory. I will say that I do not claim to understand the matter so fully as perhaps the gentleman himself does. He has gone into the matter more fully than I have. Other business has called me away from the study of these things, but I am fully convinced, nevertheless, that there is some consideration in favor of the other gauge and that while this may be entirely satisfactory, and while it has great advantages on account of its metric basis, which I recognize, yet it cannot be denied that it does not answer the purposes of the other.

MR. GARRATT: I will say in regard to an asymptotic gauge that I corresponded as far as I could with every maker and user of wire in this country and abroad, and I found just one gentleman who advocated it, and he was a distinguished mathematician in the United States Army—Captain Michaelis, of Troy. I corresponded with him on the subject and we could not come to any very good understanding. The asymptote is the property of a tangent to a parabola at infinite distance. To state it in another way it is a straight line which approaches nearer and nearer to a curve, but would never reach it, even if it was extended infinitely. I did not find any other man in the United States—I have now found another—who advocates such a gauge. In regard to the Brown & Sharpe gauge, I do not think it was right for the gentleman to suggest to have a

gauge on the same principle as the Brown & Sharpe, when that principle could not be stated by him. Then, in regard to just one more thing—he said a gauge should be used to measure sheet metal. The properties of plane surfaces and of rectilinear solid bodies follow simple mathematical laws. Will the gentleman kindly state some calculation in regard to sheet metal, its properties by weight, strength, or anything of the kind which can be more readily calculated by the Brown & Sharpe gauge, or as easily calculated as it can be by the metric system?

MR. MAILLOUX: That is not the question.

MR. GARRATT: Then I did not understand you, sir.

MR. MAILLOUX: I think the question bears more on what people have been doing, and on what we can make them do. I have no doubt it is easy enough to make a far more scientific gauge than people could use. We have the experience of this country in the rapidity with which it has adopted the metric system. I myself prefer the metric system to all others and use it a great deal. I believe that in chemical work it is the only system by which satisfactory work can be done. But at the same time I note that it is not going into use with very great rapidity. I note, on the other hand, that it is being adopted in this country with great slowness, and I doubt if the present generation will ever see the metric system in use in this country. What I have reference to is, that as people are accustomed to gauging thickness by a certain figure, we must not give them some thing which is so radically different that by its very radicalness we shall make people object to it.

MR. GARRATT: I have no reply to make to the

gentleman's objections. I did not understand that the work of this committee was to consider the peculiarity of men's minds, in adopting that which they ought not to adopt. I was instructed six months ago that the report of the last committee was accepted. That report embodied the fact that we lay aside the British standard gauge and accept the metric measuring of wire. The work of this last six months has simply been to put that into a suitable mathematical shape. I understand that that is the report of this committee. I am not reporting on what I think people will do. I am reporting on the mathematical properties of the system of measuring which was adopted six months ago. As I say, the United States Government has adopted the metric system. As a professional chemist I agree with the gentleman in his statement that it is the only system you can use in chemistry. If he had calculated as much in connection with wire as I have he would realize the the extreme facility of making such calculations by the metric system and I have no reply to make to the question of people not adopting the metric system. I believe that every person familiar with it thinks that it will be adopted. The gentleman refers to the gauge; there is no gauge. I stated simply that from this table here we can calculate the properties of wire to the hundredth of a millimeter, which is three times as fine as the present system of work from a thousandth of an inch. The unit of a tenth of a millimeter seems peculiarly adapted to fine instruments of precision. The ten thousandth of an inch is too fine, but the tenth of a millimeter seems to be just about the limit of ordinarily fine measuring

apparatus, like the micrometer screw which all electricians use in their calculations.

Dr. Moses: Mr. Chairman and members of the convention: I feel a certain diffidence in speaking on this subject, from the fact that my name appears on that committee as a member of it. I would say that though I am a member, all of the credit of the work is due in varying proportions to the other members of the committee. The honor of being put there by yourself was one that I appreciated, and when called upon to do my share of the work I was unfortunately sick, and since then I was abroad and have not been able in the last few weeks to participate in the labors of the committee. I feel, too, as if I ought to give the meed of praise to my co-members on that committee for the very comprehensive and laborious work that they have accomplished. I also feel as if I should say, in view of the probable adoption of the report, that the metric system is one so well-known and so generally used at present that there is no necessity for us to advocate it as a standard. The government has done so already. Other governments, even the German government, opposed as it is to the French, have, in a certain disguise, adopted the metric system; they were forced to do it; so that we must for the present not consider the advisability of adopting the metric system, because it forces itself upon us, and if we acknowledge it we simply acknowledge the inevitable. But there is some weight in a remark made by Mr. Mailloux that I would like to call attention to, and Mr. Garratt sounded the keynote of it when he said it was impossible to consider any standard of conductivity, because it was something that varied

with all of the commercial metals. It is a very important thing that there should be some standard always, but where you have the essential standard always varying it is very difficult to fix it. But we have in the use of the units themselves the adoption of the metric system. We are employing them constantly for all the varying moods and tenses of the current, and why may we not adapt them to the uses of the consumers of wire, since ultimately what is to be determined is the resistance of the wire—since it is the resistance of the wire entirely independent of the material that has to be calculated by the electrician, it is of the utmost importance that we should be able to calculate the resistance rapidly. Now, the resistance varies in any two specimens of wire. I take a wire—it measures such and such resistance; I twist it accidentally—it measures a different resistance. So we have to take something as we find it, and determine what we have or what we want. Now, I do not like to speak always in prophetic mood; but I think the day is not far distant when we shall have measures of resistance that will be as portable as a Brown & Sharpe wire gauge. I think that we will be able to take an ordinary lineman and give him this instrument, and let him say such and such is the resistance measured on a dial, if you please, of such and such a length, measured for him, and in the nature of the instrument itself, constant and independent of his erroneous observations. He takes a certain resistance of a certain unit, and if he can multiply—and he has probably been taught how to multiply, though he has not very extended mathematical knowledge—he can multiply that, and let the unit be an inch, a yard,

a meter—anything you please, he simply multiplies it by the number of units that he wishes to multiply by, and he has his result accurately given. Now, I do not say that that machine is invented; but I say that it is possible to invent such a machine, and to make it most exact and very portable. Now, it is immaterial to me whether my wire is iron, or gold, or silver, or whether it has a conductivity of A, B, C or D, as long as I get the greatest amount of conductivity for the least amount of resistance reciprocally for a given weight in hard cash. That is all I want to determine. When once that is determined, why, I give my order to Tom, Dick or Harry, and the man who gives me the most conductivity for the least money gets my order. It is quite immaterial to me whether it is No. 38 or No. 32. The little difference in the space that a wire occupies in a concealed fitting, or in a pipe that brings it to a light or to a telephone, does not impress me as being a matter of any very great importance. The insulation varies so in thickness, and as nearly all wires are insulated that are at present in use, it is immaterial for us to consider very absolutely what the exact diameter is. It is something entirely outside of the financial question. The question is: What is the resistance, and what is the cost? Now, those things will settle themselves the instant we have a little piece of apparatus by which we can take a unit of length and determine its resistance, and let that be done by the most uneducated person. I would, as I said in the beginning, again extend, if it is permitted to me as a member of the committee who waives any right to the praise, the thanks of the convention to the laborious members of the committee

who have sacrificed the midnight oil for the benefit of our Association. (Applause.)

MR. MASON: If I understand Mr. Garratt rightly, he states that one matter was decided at the annual meeting past of the Association, namely, that the Association adopt this system.

MR. GARRATT: Accepted it.

MR. MASON: Accepted this system. I would like to ask the Chair to inform us where it leaves us now. As I understood from Mr. Garratt, the committee was continued to perform certain clerical work. If that is so, it is simply for us to determine whether or not they have done their work. If I understood him correctly, we are not called upon now to discuss the question of this or that gauge, but of the quality of this work, and whether we will accept these tables. Will the Chair please decide that? I would say that I remember reading in our electrical newspapers that the report of the committee was adopted.

THE PRESIDENT (reading from the minutes of the last convention): Mr. Powers, of Troy, made a motion that the matter should be left in the hands of the committee for a further term, and that the committee be increased to five, with instructions to report further at the next semi-annual convention, and that in the meantime the report of the committee be accepted (the report was accepted and placed on file), and such suggestions as they made be carried out in regard to printing copies, so as to enable the members of this Association to familiarize themselves with the new gauge in case it should be adopted at the next meeting. Now, is the case thoroughly understood? The fact is,

the matter was referred back to the committee, and it has come up in the shape of a report.

MR. MASON: The mistake arose from the misuse of the word accept. In parliamentary usage, accept is tantamount to adopt.

THE PRESIDENT: No; you can accept a report and place it on file without adopting it.

MR. LYNCH: I would like to suggest that Mr. Garratt add to his already very excellent report a column showing the safe current-carrying capacity of the wires at different temperatures. It would be a fact for our country members that would be very acceptable to them.

MR. GARRATT: I would say it is simply necessary to multiply the table of areas by a simple constant. I believe that Mr. Jamieson found that in the British navy the safe limit should be one and a half amperes to the millimeter in section. That is rather a larger allowance of copper than we have used in this country, but you will find any quantity of references to that, and all you have to do is to take your area and multiply it by a simple constant which you can memorize.

MR. LYNCH: Would n't it be possible to have a few of those constants placed on this table?

MR. GARRATT: Certainly.

MR. LYNCH: I think to a great many of our members it would be extremely necessary.

MR. GARRATT: If I am so instructed, I will do so.

MR. LYNCH: Is it necessary to make a motion to that effect?

THE PRESIDENT: No.

MR. STEUART: I have heard what has been said

for and against the report of this committee, and I would add my voice to what Dr. Moses and others have stated in commendation of the admirable work done by the committee. They have gone into the subject most laboriously and intelligently, and I think the least we can do under the circumstances is to adopt the report of the committee. They were appointed a year ago; they have gone through the subject as thoroughly and laboriously as possible; they have given us the benefit of the work done, and they have produced it here in a most intelligent and thorough way, and I would therefore move that the report of the committee be adopted.

MR, LYNCH: I second the motion.

MR. PHELPS: I would like to ask what the significance would be of adopting the report. Will the Association be committed to promulgate this as a wire gauge and recommend its adoption as a wire gauge, or not? Now much has been said, but too much cannot be said of the value of this work.

THE PRESIDENT: I will answer that question of yours first. If this report be adopted, then this Association pledges itself and its members pledge themselves, or each one pledges himself individually, to carry out the law laid down by this report. You may call it whatever you please, but this committee reports a method for measuring wire which we will adopt if we adopt the report.

MR. PHELPS: The key to what I was going to say is furnished by Mr. Garratt in his remarks a little while ago, when he said there is no gauge. It is an infinitely useful compilation. A useful system is here provided

for ordering wires by diameter, and a great step in my judgment, is taken and gained in using metric diameters instead of inch diameters. But I should hesitate myself to assist in promulgating a wire gauge. I think if we were to think the matter well over, in view of Mr. Garratt's remark that there is no guage, unless you choose to call it so, but an almost infinitely useful aid to the manufacturer and orderer of wire and if the Association can promulgate this information in a way to make it useful to everybody having to make, buy or use wire, and by so doing put a peg in towards the further use of the metric system, that, it seems to me, will be a useful thing to do, but do not let us call it a new wire gauge. We have got more wire gauges than we want. You see my idea, Mr. President? I would like to hear from Mr. Garratt.

MR. GARRATT: There is no wire gauge about it. If I understand the matter right, the electric arc light men will use a definite number of wire, perhaps; the incandescent men will use a certain other definite number; the men who make hairpins will use other numbers. They will have these sizes, and it doesn't make any difference whether you express them in tenths of a millimeter, in thousandths of an inch or any other measure you see fit. All that I advocate is, that we express the size of the wire we use in the metric system, and not by an arbitrary number which means nothing.

MR. PHELPS: It is very gratifying to know that practice of ordering wire by diameter has been constantly growing of late years. It has been found a sort of necessity by people who require wire of any accuracy.

Part of the work has already been done. We are accustomed to ordering by diameter, but mostly use thousandths of an inch. This information will enable people to use a better unit of diameter, and that is the main function of it, and the information supplied here of the physical properties of wires based upon their diameters is something we have not had before, and, as I said before, should prove infinitely useful.

MR. GARRATT: If you introduce this asympotic curve you are introducing the question of high mathematics again; you are plunging us again into a new gauge; you are plunging us into something that is purely arbitrary. It will be a laborious thing for thousands of people in the United States. We measure ground by feet and rods; we measure length by thousand feet; why not express our wires in diameters and by the metric system.

THE PRESIDENT: I suggest to the Association that you make this the special order for a fixed hour on Thursday, and that will give the gentlemen an opportunity of studying the details and coming intelligently up to the work again.

MR. MASON: I move that this matter be laid on the table and be the special order for the opening of Thurday's session.

The motion was carried.

THE PRESIDENT: In the absence of Mr. Slattery, who was to have read a paper on electrical distribution by means of alternating curents, we will take up the partial report made by the Committee on insulation and construction of plant.

MR. ROBINSON: I would like just a word here in

reference to that report as a member of that committee. I have read a rough draft of the partial report the committee has made and not being able to endorse the report before it is presented to the convention I would say that the committee as a whole have resigned from the work, and as I could not endorse what they said I could not resign with them. Finding myself in a small minority, not even a fighting minority, I would ask you to accept my resignation.

THE PRESIDENT: Gentlemen of the Association you have the verbal resignation of Mr. Robinson before you. He begs to tender his resignation as a member of the committee on proper insulation of wires and proper installation and construction of plant. The reason he gives for that is that he is unable to subscribe his name to the contents of this partial report. Therefore, he tenders his resignation. What will you do with the resignation?

A MEMBER: I move that the resignation be accepted.

The President put the question, but no one voted.

THE PRESIDENT: Gentlemen of the convention: You are here to perform whatever duty is assigned to you in the regular order of the work. No man need be ashamed to vote on anything. Every man should have an opinion of some sort, and he should be able to express that fearlessly. Again, I put the question.

MR. GARRATT: We do not understand what Mr. Robinson resigns from.

THE PRESIDENT: He offers his resignation from the committee on proper insulation of wires and proper installation and construction of plant.

MR. DECAMP: Mr. Robinson is in a very awkward position. He is in so small a minority that he feels it would be presumptuous for him, I suppose, to make a report——

MR. ROBINSON: No, sir. I would like to reply to Mr. DeCamp in that matter, and say that I received a rough draft of the partial report late on Monday and therefore could only study through it hastily and supposing they were going to make a report, until yesterday, I was totally unprepared to make any report whatever. I beg that you will accept my resignation and let me out of the scrape.

THE PRESIDENT: I think it is only fair that the resignation be accepted or rejected. Again I place the question before you.

The motion to accept Mr. Robinson's resignation was then carried.

THE PRESIDENT: Before placing this paper in the hands of the Secretary to be read, I beg to say that on a date which I am unable to find in the correspondence this committee—either all six, or one of its members, perhaps more, wrote to me asking that the National Electric Light Association furnished them with a fund of $1,000 to carry on their investigations and guarantee the cost of repair to any apparatus that might be damaged in the course of their investigations—apparatus which was to be supplied to them from the University of Pennsylvania; also that an assistant be furnished at $3.00 a day. I laid that correspondence before the Executive Committee which met in Boston on June 9th. The committee found only one course open to them. The funds of this Association are applied to its running

expenses, with which you are all familiar. There was no such sum on hand to be turned over to the committee. Nothing more was heard from the committee until this paper, with quite a column of printed matter, was sent in yesterday or the day before to the National Electric Light Association. Now this paper is signed by Edwin J. Houston, chairman, William D. Marks, Carl Hering and M. M. Garver, and is not signed by Mr. Robinson, and the reason he gave for his resignation, independent of this paper, was that he could not subscribe to the subject matter contained in this report.

Mr. Secretary, read the report.

The following report was then read by the Secretary.

REPORT OF THE COMMITTEE OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION "ON PROPER INSULATION OF WIRES AND PROPER INSTALLATION AND CONSTRUCTION OF PLANTS."

The committee appointed by your honorable body hereby respectfully submits the following report:

The rapid growth of the electric lighting interests during the last decade, the large investments already made in such interests, together with the still greater growth that is probable in the near future, have strongly impressed your committee with the important nature of the work intrusted to them.

Your committee fully recognized the fact that any report to an Association that represents the leading electric lighting interests of the country, would naturally be expected to be of a thorough character; they therefore determined as far as lay in their power, to spare no labor in the performance of their work.

The duties charged on the committee naturally divide themselves into two general classes, viz:

First. The proper insulation of the wires or leadiug conductors.

Second. The proper installation and construction of the plant as far as relates to the insulation and protection of the machines, lamps, conductors and accessories, and to the safety of consumers, attendants and buildings.

The first branch necessitates an exhaustive and carefully planned series of practical tests as to the insulation of the leading wires; the second, the preparation of a Code of Rules, based on actual experience for the general installation of the plant, both so far as concerns the insulation thereof, and for its protection, as well as that of the consumers, attendants and buildings; or, in other words, to provide for such an installation of the plant as will best ensure the protection of life and property.

Referring to the first branch of its work, your committee appreciates the fact that a mere theoretical discussion of the subject would prove of but little value to an Association composed of men practically engaged in electric lighting. They are aware that considerable valuable data have already been accumulated concerning the high insulation required for telegraphic cables, especially submarine. They are also aware that laboratory tests have been made of ordinary electric wires. These data, however, either refer to conductors not included in the scope of your committee's investigations, or, though referring to electric light conductors,

have been made under conditions that would render them of but little practical value in this connection.

Your committee therefore planned to make a careful series of practical tests under conditions as nearly as possible similar to those to which the conductors are actually subjected in existing installations.

The committee determined to limit their investigations chiefly to the leads that are ordinarily used in arc and incandescent lighting, subjecting them during such tests, as nearly as possible, to the various disturbing or other conditions that are met with in actual practice. They hope by these means not only to obtain data by which the ralative commercial efficiency of the different wires in the market could be determined, but also possibly to lead to the determination of the best conditions to be observed in the manufacture of insulated wire, in order to insure the production of the most serviceable material.

Tests, such as those contemplated, and of necessity required by the character of the work, not only called for excessive labors on a part of the committee, but also for the use of specially designed apparatus. Although the committee had the use of the well equipped electrical laboratory of the University of Pennsylvania, kindly placed at their disposal by Prof. Marks, one of the committee, and the use of valuable apparatus belonging to other members of the committee additional apparatus was required, which, if specially designed, must be purchased, or if of existing types must be borrowed. Then too the services of an assistant were required to start and look after the fire for the steam engine, clean out the boiler, run

circuits, and do such other work as the committee could not be expected to do.

In order to obtain for these tests currents similar to those in actual practice, various dynamo electric machines would necessarily have to be borrowed.

In view of these facts, the committee deemed it but fair to request the Association to guarantee a sum sufficient to meet actual expenditures, and further to assume responsibilities for apparatus loaned to the committee, feeling sure that the Association could hardly expect the committee to assume such expense in carrying out work of the character entrusted to them.

This request, the committee were informed by your representatives could not be entertained. The committee are therefore forced to resign.

Desiring however, to give to the Association such incomplete parts of their work as represented the results of their labors up to this time, they beg leave to submit the following incomplete report:

First. On the preliminary code proposed for the tests on insulation of the conductors, etc.

Second. On an incomplete draught of a preparatory code of rules and regulations for the installation of an electric plant intended to serve as a basis of the experiment by the committee, and to be sent in printed form to the various electric companies and insurance interests for comment and criticism, before finally being submitted to the Association.

As regards the preliminary code of tests, however, your committee desire to be distinctly understood that they recognize the fact that preliminary tests on such code would in all probability show the code to be

impracticable in certain portions, or at least to need modifications or additions.

In the preparation of the following preliminary code the committee bore in mind that leads possessing the requisite durability and efficiency for electric work, should possess as far as possible, the following requisites, viz:

First. High insulation.

Second. Impermeability to moisture.

Third. Incombustibility.

In this view we submit the following preliminary code for tests, subject to the changes, modifications or extensions already referred to.

PRELIMINARY CODE.

(1.) LEAKAGE TESTS (Arc Wires.)

A definite length of insulated arc light wire to be immersed all but the ends in water. The water is connected to one pole and the copper to the other pole of a machine giving 3,000 volts, which is assumed to be the highest electric motive force ever used in practice. The leakage from the copper through the insulation to be continuously measured by a suitable Ampere meter, the measurements beginning immediately on the immersion of the wires, and the tests to be stopped when the leakage reaches a certain definite amount. The greater or less rapidity of increase of leakage, may then be assumed to indicate the less or greater value of the insulation.

INCANDESCENT WIRES.

Incandescent wires will be subjected to similar tests, differing only in the voltage to which the insulation is to be subjected which will be in the neighborhood of from 100 to 150 volts, since, as is known, at a voltage of say, 60 volts moisture does not seriously interfere with ordinary underwriters' wire, while a somewhat higher voltage will set fire to wood through underwriters' insulation.

(2.) ABSORPTION TESTS.

Coils of wire of definite length are immersed in water, and their ability to resist penetration or absorption thereof, will be measured by the increase in weight after equal duration of immersion.

(3.) FROST TESTS.

The ability of the insulation to resist the disintegrating effects of frost, on the alternate freezing and melting of the absorbed moisture, will be tested by the similar effects produced by the alternate absorption and crystalization of a solution of some chemically inert salt, such as magnesium sulphate.

After the wires have been subjected to the frost tests (3), the leakage tests (1), and the absorption tests (2) will be repeated.

(4.) FLEXIBILITY OF INSULATION.

A definite length of wire will be wound around a small cylindrical rod, say one inch in diameter, after which the leakage and absorbtion tests (1) and (2), will again be repeated.

(5.) ABRASION TESTS.

A definite length of wire will be bent in the form of an inverted U, having a given radius of curvature and will be hung over a wheel, such for instance as a gear wheel having polished teeth with rounded edges, and heavy weights will be attached to the two ends of the wire. The wheel will then be turned and the number of turns noted before electrical contact is made between the copper of the wire and the metal wheel.

(6.) ADHESION OF THE INSULATION.

A definite length of wire is bared of its insulation at one extremity, and the bared end passed through a closely fitting hole in a die plate. A measure pull is then exerted on the bare end of the wire until a definite length of the insulation is stripped off the wire.

(7.) REFRACTORY QUALITIES OF THE INSULATION.

The current will be passed through given specimens of the wire and increased in quantity until the insulation is destroyed and the nature of the destruction noted, whether in the form of flame, charring, etc., etc.

(8.) IGNITION TESTS.

The ability of the insulation to resist ignition by some external source of heat similarly applied to all the wires, and the rapidity with which the flame started at one point travels along the wire, will be carefully noted.

Besides the foregoing tests as to the quality of the insulation, the committee also proposed testing the conductivity and flexibility of the copper, as follows, viz:

(9.) CONDUCTIVITY TESTS.

The conductivity of the copper will be measured

assuming the wire to have the diameter claimed by the makers.

(10.) FLEXIBILITY TESTS.

A given piece of wire will be bent repeatedly backwards and forwards around a templet, curved to a quadrant of say one inch radius, the number of bendings required to break it being noted. In order to procure wire of the same quality as that commercially sold in the open market, it was proposed to purchase the specimens tested in the open market, direct from the makers.

The second duty charged on the committee was, as already stated, the preparation of a code of rules, based on actual experience, for the general installation of plants, both so far as concerns the insulation thereof, and for the protection of the plant, consumers, attendants and buildings.

The importance of a Code of Rules of this character, relating as it does to the better protection of life and property, is generally recognized, both by electric lighting and insurance interests. It is to the true interests of the electric lighting companies to assure the public that not only can they through electricity furnish a steady, reliable and cheap illuminant, but that such illuminant, if intelligently employed under certain well considered regulations, is as safe, indeed, far safer than any other artificial illuminant. While, therefore, electric lighting companies should not hesitate at the adoption of the most stringent regulations that experience has found necessary for the protection of either life or property, it is of course advisable that all arbitrary and meaningless regulations should be carefully considered before their adoption by the National

Electric Light Association. It has therefore been the aim of your committee to obtain a code acceptable alike to electric lighting and insurance interests.

As preparatory to the framing of such a code of rules, the committee planned the following work, viz.:

1st. The preparation of a compilation of existing rules.

2nd. Obtaining the opinions of the principal Electric Light and Insurance Companies as to the practicability of existing rules and requesting suggestions of such changes or additions, if any, their experience might suggest.

3rd. Conducting a series of experiments so as to determine, as far as practicable, reliable data on which a code could be deduced affording the widest latitude to Electric Light and Power Companies consistent with absolute safety to life and property.

4th. From the above to deduce a code to be regarded as a preliminary code.

5th. To have printed copies of such preliminary code sent to all Electric Lighting and Insurance Companies for comment and criticism.

6th. To prepare finally a code to be submitted to the National Electric Light Association, to be known as the Code of the NATIONAL ELECTRIC LIGHT ASSOCIATION OF AMERICA.

In carrying out this branch of its work, the Committee has addressed letters to Electric Lighting and Insurance Interests, asking for copies of existing rules, etc. To a certain extent these letters have been answered and copies of existing rules and regulations (though by no means complete), have been received and the Committee

had commenced a compilation of the same. In the desire of aiding the Association, they hereby respectfully submit such incomplete collection and compilation.

Being forced to abandon their work by reason of the failure of the Association to make the appropriations necessary to carry out the same, the committee hereby submit the above incomplete report, and respectfully offer their resignations as members of the committee and request that they be relieved from any further work in the matter.

Respectfully submitted,

EDWIN J. HOUSTON, *Chairman.*
WM. D. MARKS,
CARL HERING,
M. M. GARVER.

MR. KINSMAN: Is there any item there in regard to the time test—that is the cracking of the wire?

THE PRESIDENT: No sir.

MR. KINSMAN: I move that that be introduced. I have some experience on wires that tested well before we put them in but did not stand the pressure of time.

THE PRESIDENT: There were no exhaustive tests made by this committee at all. They had completed their work to a point where they required financial aid to carry it on. They applied to the Association for that aid. The Association was unable to give it, and the committee present this report and resign. It is put in plain and unmistakeable language so that you may know if you want any further work done you will have to pay for it. The paper is open for discussion or for whatever disposition you choose to make of it.

Mr. Eustis: We have had some little experience in wire. A good many years ago when I was with the Bell Telephone Company, I decided to test a wire there and made out a report of the wire. It tested splendidly after soaking for about two weeks. I made out my report, but fortunately it was not handed in. I put the wire up on the shelf and glancing at it I saw that the insulation was cracked from one end to the other, showing that while the wire might test perfectly well while still wet, after it had dried out a trifle, it was absolutely no good. For practical working, that of course is a strong point—that a wire should last and not become oxydized and cracked. There is also the other question which I think should be brought up there, and that is the question of mechanical injury to the covering—abrasion. We all know wires are strung where they are liable to swing against awnings, the fronts of houses, trees and so forth. That I think is also a question which should be brought up here.

Mr. Mason: I suppose we must decide this question now whether money shall be appropriated for such an object. I do not suppose, Mr. President, that another committee could be found who would undertake the work which this committee has declined to pursue and undertake it at their own expense. I wish I could hope that I was wrong on that point; but I do not believe that any comittee will undertake an expense of a thousand or two thousand dollars and pay it out of their own pockets. At any rate, although I am very anxious indeed from my own point of view, that the work which was given to this committee shall be done, I do not feel like asking any committee to bear that expense. It

seems to me as if the necessary expense of making tests, the results of which would be so valuable to the members of this Association—it seems to me that we ought not to shrink from incurring that expense. I want to test this thing and so to bring it before you, I move that the resignations of this committee be accepted and that their partial report be also accepted, proposing to move the appointment of a committee and the appropriation of a suitable amount of money to enable them to carry out such plans as they shall deem wise for the determination of the end sought by the committee whose resignation is now offered. I move the acceptance of the partial report and of the resignation of the members of the committee whose names are thereto appended.

The motion was seconded.

MR. DECAMP: I understood from that report as well as from Professor Houston personally that that is not made in the nature of a report — that they could not report for lack of funds to carry out their investigations. What they have said there is in the nature of suggestion.

MR. MASON: They use the term partial report, do they not, Mr. President?

THE PRESIDENT: Yes.

MR. DECAMP: I do not think that the committee want to be responsible for that report. The question arose in my mind what disposition we ought to make of it.

MR. LEGGETT: It suggests itself to me the same as to Mr. DeCamp, that in as much as the committee admits this to be far short of a report that it would be

better to accept their resignation in view of the circumstances which they have set forth and to lay this report upon the table.

The motion was seconded.

THE PRESIDENT: Do you offer that as a substitute for Mr. Mason's motion?

MR. LEGGETT: Yes, sir.

MR. MASON: I understood you to say, Mr. President, that I am right in my memory—that the gentlemen who sent us this communication style it a partial report, I therefore make my motion that their parrial report be accepted.

THE PRESIDENT: They style it here: Report of the committee of the National Electric Light Association on the proper insulation of wires and the proper installation of plant; and they say "The committee appointed by your honorable body respectfully submit the following report."

MR. MASON: And afterwards they speak of it as a partial report. If not, I should wish to modify my motion.

THE PRESIDENT: You better modify your motion; this is a report.

MR. MASON: It would not be in order for me to make that amendment in view of the one before you. I will withdraw the word "partial" with the consent of the body.

MR. LEGGETT: Then I renew the motion that this report, which is admittedly incomplete, and for which the committee would not probably want to make themselves responsible, or the convention desire to accept as an expression of its will, be laid on the table.

This motion was put and carried.

THE PRESIDENT: The Boston Electric Club have extended an invitation to the members of this Association to attend a banquet to be given on Wednesday night at the Point of Pines and they request that the members of the Association call at Room No. 14 and give a written acceptance of this invitation.

The chair is now ready to entertain a motion to adjourn to an hour. Whoever makes the motion, make the hour.

MR. LYNCH: I move that we adjourn until two o'clock.

MR. DECAMP: I amend that by making it three o'clock.

THE PRESIDENT: That is two hours and seven minutes; that is too long.

MR. LYNCH: Half-past two.

THE PRESIDENT: I hope the members will all be in their seats at half-past two. You have only a short time to consider a great many very important subjects. The first paper will be the report of the committee on electrical distribution by means of alternating currents by Mr. Slattery. That will be the first paper after the dinner hour. At half-past two o'clock we will begin the business sharp. This paper is a very important one as it deals with a new branch of the electric business which has been developing quite rapidly of late.

The convention then adjourned until 2.30 P. M.

AFTERNOON SESSION

The convention was called to order by the President at 2.30 P. M.

THE PRESIDENT: The first business of the afternoon session is the report of the committee on electrical distribution by means of the alternating current.

MR. SLATTERY: I regret to have to announce the absence of our very able Chairman who had to report upon this important subject, secondary generators. In his absence, that duty devolves upon me and I feel the *onus* of the obligation involved of doing justice to a subject which is fraught with a great many perplexities.

Mr. Slattery then read the following report: —

REPORT OF COMMITTEE ON ELECTRICAL DISTRIBUTION BY MEANS OF ALTERNATING CURRENTS.

One short year ago the commercial success of that branch of electric lighting in which induction coils are used was by some of our best authorities considered very problematical, but practical use of the induction system has not only succeeded in commercially converting high tension electricity to low tension for electric lighting purposes, but also high tension theoretical opponents by practical demonstration of facts.

Upon the occasion of the last convention the extensive use of the induction system received its first authoritative endorsement by our esteemed friend, Dr. Otto Moses, and although he was by some considered over enthusiastic in his statements, time has served to prove the correctness of his views and the realization of many of his anticipations.

We will go back six months and mentally what do

we see in this business? A few experimental plants scattered about in various parts of the country struggling for public recognition and with the innumerable detail difficulties which dog the footsteps of every new departure, difficulties the magnitude of which are usually in proportion to our ignorance of their nature and therefore more frequently than not unduly magnified.

Now what have those difficulties been and has the past six months experience enabled the manufacturers engaged in this branch of business to eliminate them?

We find there were three factors in the induction system that required all the ability of the electrical engineer to work out and place upon a proper footing, namely the Dynamo Machine, the Induction Coil and the disposition of the external circuit to take the best advantage of the use of the induction coil.

Of course there were alternating dynamos in existence as were also induction coils before this lighting branch of business had acquired any prominence, but they were not such as would meet the new requirements.

We will first take the dynamo. It will be familiar to all of you that no matter how intimately acquainted you may be with the construction of dynamo machines, when you start in to build a new type, your previous experience, however valuable it may be, does not enable you to foresee innumerable detail defects which will assuredly develop with practical use and which take time to ascertain and remedy. Well, so far as we have been able to learn, the weaknesses which developed in this apparatus were, first, the liability of the current to jump across the coils in the event of the field being

excited with the armature circuit open. This open circuit sometimes happened by a dead cross occurring some place in the mains, blowing the fuse at the dynamo, thus opening the circuit and then the field being fully excited the armature would generate an exceedingly high electric motive force for an instant; the current under the circumstances would be very liable to jump across the coils of the armature and other hurtful effects to the machine would ensue, the remedy for that was, inserting at every branch in the external circuit a junction fuse and at various points along the mains and sub-mains section fuses to such an extent as to make an open main a remote contingency. It was also found that the armatures heated excessively owing to the presence of the plaguey Foucault currents, it was found that this evil could be almost wholly suppressed by building the armature without iron and avoiding as much as possible the use of solid masses of metal in proximity with the armature coils; in this connection Siemen's early type of alternating dynamo slightly modified to meet the new requirements might read us a lesson.

It was a bold step when the alternating dynamos were constructed with iron cores and those who make this class of machine for this high tension incandescent business might give us some interesting information. To our mind and from what we have been able to ascertain, this iron core construction speaks of disagreeably high temperature. I do not say that the company's making this class of dynamo will not be able to present a rational theory why this evil may not be overcome or that it has been greatly modified, but the fact existed in the past and as far as we have been able to ascertain

pretty evident, that just now this type of machine appears to be finding a rather extensive use evidencing that it must be doing good work. So much for the alternating current dynamo—a machine which is destined to play a most important part in the future electric lighting business and in the light of the past experience and the good work now being done, no doubt, should exist in the minds of any one here, that alternating dynamos for practical use can be made almost if not quite as reliable as any other dynamo, while coupled with this is the important factor of a pretty close self-regulating property attainable in this system, without the necessity for any particular method of winding, that property following chiefly as the result of the use of the induction coils. It is satisfactory to know that during the probation of this system every accident of any importance which has occurred to the dynamo has been of a purely mechanical nature, and our mechanics have reduced them to a minimum.

No doubt the induction coils have been a source of considerable anxiety, not because there was any obstacle in the way of obtaining high electrical efficiency; this latter appears not to have been by any means a difficult problem to solve. The source of greatest trouble has been, as far as we can learn, that of insulation. In what form will the weaknesses appear in this apparatus has been a question often asked himself by the timid electrician and as usual the most unlooked for troubles developed. At one time an unaccountable defect in the insulation of the secondary coil would occur cutting out a number of its convolutions thereby causing annoyance by reducing the stands unrefuted at present. One thing, however, is

incandescence of the lamps in its circuit. The remedy was simple — increase the insulation of the wire and exercise greater care. The same accident would still more frequently and seriously happen to the primary coil, the same remedy applied overcame it,—sometimes a number of the layers of the primary coil would thus be suddenly cut out resulting in the passage of a much heavier current than the fuse in the coil box had carrying capacity for, the fuse would then melt and possibly draw an arc that you had a great deal rather do without if you could, the remedy for that was keep on insulating the primary coil layers from each other until the trouble ceased and increase the distance between the ends of the primary fuse to such an extent that when the latter melted, an arc, no matter how great its volume, would not be able to bridge over this distance which after all was calculable because the E. M. F. was constant. Then again in the face of unusual precautions metallic contact would take place between the induction coil and the iron box in which it was mounted and if that box happened to be placed anywhere near a ground, possibly unpleasant electrical experiences might be related in wet weather. It was again only a question of looking out for the insulation to reduce such defects to a minimum. Well, the insulation appears to have been looked out for, as the smooth and safe working of that branch of the business would now seem to testify, and to-day, that part of the system can be made as reliable, simple and easily disposed of, as any other part of an incandescent system.

Thus the two new and troublesome factors have gradually and surely been strengthened for their future work.

The next factor in the system, viz: that method of distribution which would enable you to utilize the induction coils to the best advantage, although apparently presenting the simplest problems at the outset, has required a great deal more thought than was anticipated. It was found that no particular rule, as in the case of low tension distribution, could be carried out, the methods of distribution varying with the conditions of the district in which you had to distribute.

In some cases the wires were run out from the central station through the centre of distribution and tapped at any point along the route where lights were required. This was the earliest and simplest form of distribution and answers perfectly well for comparatively small installations, care being taken to keep the loss in the mains down to about two per cent. and perhaps about two to three per cent. in the induction coils so that the incandescence of the lamps should not vary appreciably throughout the system; this arrangement of the circuit may be carried out in small and very scattered towns, where it has been found to answer admirably. In other cases where the district is more densely populated and a large installation is required, the inductoriums are placed in centres of distribution and used like so many stationary dynamos, the high tension primary current with comparatively small conductors feeding each of these centres, the secondary or distributing circuit being taken wherever lights are required.

Still other methods of distribution are carried out, but what has been stated in this connection will serve to show that again the past year's familiarity with the

business has given an opportunity to perceive and profit by many advantages the system offers.

One of the last, but by no means least points, that I shall touch upon in this interesting subject, is the question of comparative cost of the main conductors required in an installation of an induction and low tension incandescent plant. Not at all unfrequently we shall find ourselves called upon to figure upon a plant like this.

From the source of generation to the point of distribution is a mile and a half, making a three mile circuit; at the point of distribution you are required to distribute some 400 16 c. p. lamps at say five per cent. fall of potential which appears to be about the limit allowed in the induction system. The necessary conductors for this purpose in the induction systems now in use would be No. 2 Brown & Sharpe, which will cost about $235 per mile. In the case of the low tension installation, you would require conductors costing about $1050 per mile.

Should you be required to distribute throughout the whole of the length of the circuit, the wire such as is used for ordinary arc lighting purposes would be amply sufficient for the induction, and of course a proportionate reduction may be made in the low tension system.

Now a great many exaggerated statements are made with regard to the dangerous shocks to be expected from this alternating current and while we are not prepared to say that the physiological experience of a shock from a thousand volt dynamo is the most agreeable thing in the world, we are prepared to say that the shock is by no means as severe as that received from a

continuous current dynamo of the same voltage. A few weeks ago a man showed one of his hands which was horribly burned; he had received a shock from an eleven hundred volt dynamo and he said with a visible tremor in his arms as if the recollection of that shock was still vividily impressed upon his mind, that he experienced the effect of the shock for more than a week afterwards. A friend of mine was testing a 400 light 1050 volt alternating dynamo fully loaded only a few days ago, and going towards the machine his foot slipped and he fell quite close to it; in his confusion he reached out his hands, and unfortunately placed them directly upon the poles of the dynamo. He said from where he fell to the wall behind him was about fifteen feet and it seemed to him as if that dynamo was suddenly converted into an electrical gun, and he got shot across the room until the velocity of the movement was interfered with by the wall. There was scarcely the appearance of a burn on his hands, merely a pin's head matter, while the effect of the shock was felt by him only for a few hours. It might be said that the difference of the effect of the shock was owing to the difference in the temperament of the two men; that may be so, but I have received three pretty severe shocks from a 1000 volt alternating machine, and however much I may have felt inclined to dispense with the shaking up it gave me, the experience has been of value to me; one cannot have everything.

One more word in conclusion—the induction system has evidently come to stay, not because enthusiastic advocates, think, or say so, but because the expert public, the central station public, have practically

endorsed it, because it more nearly than anything else meets their immediate, and anticipates many of their future, requirements. More especially is its advent doubly welcome just now with this misconducted overhead conductor warfare pressing on every side, and which is every day acquiring seriousness in proportion to the increase of copper wire in the air, and I think that this system with its comparatively small mass of conductors will postpone for a considerable time the necessity of going underground with the electric light wires until more extended experiments shall have given us the confidence in underground systems that experience in the past has naturally shaken.

M. M. M. SLATTERY.

THE PRESIDENT: Gentlemen, Mr. Slattery's paper is now before you for discussion.

MR. SLATTERY: If I might make a suggestion, sir, we have our old friend, Mr. Duncan, present, who is fully charged with alternating effects this afternoon, and we shall be very pleased to receive a shock from him.

MR. DUNCAN: I am not very well charged to-day. It has been a very fatiguing day for me. The atmosphere of this room is not such as was represented by the Mayor of Boston. In regard to the alternating current system, I have simply to say that there is no question about the practical and efficient working of that system. There are some things which required a practical demonstration to bring them out, and there are some things about the system yet which are not fully solved but which are being rapidily evolved. There is no question about the covering of a given space

and the distribution of a large number of lights much more enomically, than by the direct system. Now, as to the question that comes up in regard to the difficulties suggested by Mr. Slattery, those are questions which are gradually working themselves out as he stated in his excellent paper. One of the difficulties which was first experienced, as he says, was the induction box itself, but practical experience of four months in the use of that box has been such as to show that in every respect it is entirely efficient, entirely satisfactory and that it can be relied upon to be placed in any position to do its work effectually and efficiently.

In regard to the dynamo, he has gone through that part of it. There is some heat naturally generated from any dynamo. I do not know that I can say that we get any more heat from the alternating current dynamo than we do from the regular arc light dynamo. I do not think we get much less; I know we do not get a great deal more. In the heating of the parts in the original machines that were made there was considerable difficulty. Insulation has been provided from time to time, and, at the present time, I know of machines which have run successfully for three months to which nothing has ever been done. Some of these machines will average in a week's run twenty-four hours per day, except Sunday, and they will be shut down on Sunday for about two hours. In regard to the efficiency of the system I am satisfied, myself, from my own knowledge and from the experience we have had with it, that for long distance lighting, for doing city lighting, for covering a straggling community where the lights will be necessarily very much scattered and where it is not

a compact part of the city like most centres, that you can do it more efficiently and more economically with that system than you can with the direct.

I don't know of anything else I could say that would be interesting to the convention. There are others here who have had more time to look into the details of the system than I have had.

Mr. Smith (Allegheny City Electric Light Company): Mr. President, I would say that I have had some experience with the alternating system in the same company with which Mr. Duncan is connected, and also with another company in Philadelphia where we started first with the direct system, and changed it to the alternating. Some of the points which Mr. Slattery has asked for information on I may be able to give him some information about. We have found that where we are using the converter system its enormous flexibility enables us to apply almost any system you want. In one of our stations in Pittsburg where we rent lights in a poor neighborhood where the majority of places would demand three or four or five lamps, we found it cheaper to place the converters on the place, using either 50 volt or 100 volt lamps, as we pleased. In the other parts of the town, where we found buildings taking ten, fifteen or twenty lights, we found it better to take the high tension right into the building and place the converter in the cellar or the garret. In some cases, we have a mixture of the systems. For watchmen's lights we have both the secondary main outside and the converters directly in the building. In very large buildings we carried the high pressure mains over the building—that is, through

the building and tapped to our converters wherever convenient. In the case of hotels, we have a high pressure wire down to the center of the corridor and in the case of a large parlor being lighted, we would put a converter into that parlor. In the case of a row of bedrooms requiring twenty lights, we would put in a twenty light converter. Without the slightest trouble we change buildings having three or four hundred lights from one system to the other without cutting off the lights for a moment, by cutting up the existing wires as they exist in the sections and tapping in the converters one after another as we needed them. Whenever we wished to change a section we would substitute our 50 volt lamps for 100 volt lamps. When we had all the lamps changed in a building we would splice up where we had cut. In a building having 300 lamps we only put in converter capacity for 200, knowing that no more than 200 lights would be burned at one time.

As regards the danger of shocks I have had a little experience on both sides. I have had a full share of the arc light shock. I opened circuit on 1,500 volts, which was sufficient for me. I have also taken a thousand volts alternating, and there is no comparison between the shocks at all. If I may be allowed to give my own experience, I should say that the Thomson-Houston machine gives about the most tremendous blow I have ever felt. It is a peculiar dead stroke which you do not find in the Brush. But the alternating machine seems to throw you off instantly; you do not have time to take hold. We had a case in Philadelphia the other day which I think will be something for Mr. DeCamp

to hear, as I believe he feared it was one of his men. We had been changing one of these buildings from direct to alternating, and while the building was still on the direct current, one of our wire men went into the cellar and tapped an ordinary key socket onto the mains to give him light. After the building had been turned into alternating current, one of these wires which had been used originally became a dead wire, and the lamp having been taken out of the socket there was no current passing through the wire. One of our men went down stairs to make some changes and our foreman cautioned him particularly to look out for those alternating current wires, as one of them was grounded. Two of the men went down together and one of them forgetting that the thing had been changed to alternating went feeling around to get hold of this socket, and he found it, and he lay down on the wet ground and the other man stumbled over him and spoke to him, but received no answer, and he spoke to him again. He stooped and looked at him, and finding he was black in the face ran off to call for help. He ran down to the station and while there learned that the foreman had gone to another building and he ran after him. By the time he found him, and got back, the foreman told him that the moment he heard something was wrong there he knew what it was. He ran down to the cellar and found this man lying on his back perfectly still and blue in the face. He stooped down and shook him and got a terrific shock himself. He saw that he still had hold of the socket, and he took his coat so that he would not get the shock himself, and pulled the wire out of the man's hand, and then they picked him up. He had

been on the current, as near as we could estimate, four minutes, taking the full benefit of a thousand volt current. The men did not know what to do, but fortunately treated him for asphyxia. The man was blue in the face. They cut his clothes open and dashed water on him and tried artificial respiration and in the meantime sent for an ambulance. By the time the ambulance got there, he was sitting up and refused to get into the ambulance and seemed to be very much disgusted that an old arc light man like himself should be keeled over in that way by an alternating current. The next day he expressed himself as perfectly well and ready to go to work. We had some difficulty in getting him to go and see the doctor but we insisted on it. We were more afraid of the nervous shock than anything else. The doctor told us that he was badly burned. The structure of the skin had been destroyed, as is usual in all electric burns, and the burn had extended some distance under the skin and had followed two or three inches under the skin, and he said that the real danger was in the burn. He said if it was opened up the whole length he would recover with very little trouble. The man told us that for at least two minutes of the time he was on the wire he was perfectly conscious, that he knew his companion was there and he tried to tell him to pull the wire away, but he could not speak, and that when the man went away he knew perfectly well he had gone for assistance and then realized that it would be three or four minutes before he got back and he thought to himself that he could not stand it that length of time, and then he forgot everything. He said that he felt no particular pain. He got a shock

that he would get from any electric current, when he first laid hold of it, but after that he felt nothing. The sensation seemed to be like that of drowning. As soon as we got him to gasp and breathe, his color came back again. This incident has given me quite a new hold on the alternating current system—to know that you can take 1,000 volts of it and stay on it that length of time. I know I should be very sorry to take a direct current, one quarter of that time.

As to the question of heating up machines, I would say that on the newer machines such as we are using now, we run them for a week, starting on Sunday afternoon and running until Sunday morning. It runs from nothing—an amount which you cannot read—to 35 or 40 amperes, and in all that time, it never gets so hot that you cannot bear it with your hand with comfort. On the larger size machines we are using in Pittsburg—we have one there that has been running two months—a 30 light machine—running 23 3-4 hours a day. We only stop for ten minutes and if the engineer does not feel like it, he doesn't stop then. The load on that varies from nothing up to 65 or 70 amperes. You can always bear your hand on the machine and as long as you can bear your hand on it, it is certainly not hot enough to injure any good insulation. The converters we know absolutely nothing about. We put them in and that is the end of it. I think we had to take two out on account of the blowing out of the plugs. The secondaries were short-circuited, the effect of which is generally to blow out the primary plug. It does not injure the converter as far as we have been able to find. We have never had a case of a converter

short-circuited either in the primary or the secondary. We have occasionally had a converter terribly overloaded, when it will heat up and finally blow the plugs through another converter which is tapped in on the secondary wire. It is hard to get linemen to understand that where two converters are coupled together and one of them gets hot it is usually the other converter that is at fault. I am a little of an enthusiast on the subject of alternating currents, as in Pittsburg we are using the direct system multiple arc and we have been struggling with oooo wires, pulling our poles out of line and the direct current machine burning armatures. In Pittsburg we put them to very severe duty, owing to the suddenness with which storms come up there. I have known a current in our station to jump from 300 to 2000 amperes inside of 15 minutes. But taking the two systems into account, the ease of distribution and the ease of handling, I say that the alternating system, is bound to come, if for nothing else for the enormous reduction it makes in the cost of running your station.

Dr. Moses: I am very well pleased to hear some of the details Mr. Smith has mentioned. I feel myself a little responsible for the success of that system inasmuch as I then thought it would succeed and now I want it to succeed. The alternating machines which I saw at Pittsburg were running very well and had only been running for one month when I made that report to the last convention—as my neighbor facetiously remarks, that very extraordinary report. However, I have just returned from abroad and thought that before coming here I could not spend the two days necessary to get over the *mal de mer* better than in going to Pitts-

burg and seeing how that machine was running. I am very happy to say that the same machine is running in that station in South Pittsburg that Mr. Smith speaks of, with this additional fact, that they have doubled up all around in their capacity—not doubling, however, that lone, solitary man that Mr. Weeks saw there when he meandered through Pittsburg and looked at the alternating current system. The same man was there. They had doubled up the capacity, but that same one man was running it, and I did not see that he had any more work to do than he had before. They were running 3000 lights where before they had been running 1500. While wandering through Pittsburg and seeing thousands and tens of thousands of incandescent lights which they have about in all directions, I noted the progress that had been made by the principal company there engaged in the alternating current system and I saw one thing there that I would like to call to the attention of this convention as being one of the most important things in connection with the development of alternating electric lighting that I have yet seen or heard of. When I went there six months ago, they were making machines of 500 to 1000 lights. The other day when I went up there, I saw a 2500 light machine running and doing its work admirably well and here is the thing that is so remarkable, and that I will call special attention to. The machine simply seemed to have been looked at through glasses of gradual magnifying power; that is to say, the 500 light machine was of certain size, 1,000 light machine so much larger and so on, but it was exactly the same machine in all its details. In a continuous

current machine, if you want to vary the output of the machine by increasing the parts, you will find yourself, when you begin your work, quite at sea. No one can calculate exactly what he is going to get at. True, there is a good deal of pleasure in guessing right, but if you do not happen to guess right, it is very disagreeable and costly. But here in the alternating current machine, you see a possibility, under certain forms of the machine, of quadrupling the output without changing the form of the machine at all. Now, where is that going to stop? It is but a step to say that we will be making some day in the simplest manner ten thousand light machines that will require no more attention than the same solitary man that we saw at the South Pittsburg station. The strength of the materials is the only limit to the length of the shaft bearing the armature and I do not see really where the limit is going to be; so if you want to put in central station work, it seems to me that on an alternating current machine, you may do an unlimited amount of work and get rid of all this great trouble you have had in doubling up machines, looking after commutators and all that difficulty which naturally limits the age of a plant. That is a fact that I think will be of value to the convention and I give it.

MR. KIMBALL: In regard to the alternating system of supplying incandescent lights, since the last convention in Philadelphia, there has been a marked advance, and from the various installations which are at present in operation, we have been able to get data which are not only interesting, but useful, and the question of insulation of the high potential wires is one which appeals to every one in every part of electric lighting

stations, whether in the lineman or the central station general manager. In one case it is life and limb; in the other it is property. Regarding the danger of carrying high potential wires into sockets, there are many cases where it is convenient to make an armature instead of putting a converter high up on a fixture in a city where you are not allowed to put it on poles—it is very inconvenient to put a converter for 100 lights on top of a man's building and carry one or two down into a store to distribute the incandescent light simply because you are running with 52 volts, and if a way can be devised for enabling us to carry safely the currents which, to say the least, approach the intensity of the arc current into our cellars without that sense of danger, it is the thing that is needed at present.

The question of the insulation between the primary and the secondary of the induction coil is one which is governed by a variety of causes. Where converters are placed out of doors, moisture will get in and grounds will develop on the high tension wires, no matter how carefully the poles may be wired, either from defective wiring as far as relative insulation in positive and negative wire, or possibly we may have ground wires and this bold expedient of grounding the inside wiring by heavy metallic lines to the ground has been brought to the attention of this convention before and has been published in some of the electrical papers, and it seems to me that opens a field for discussion. The fact must be appreciated that each system of incandescent wiring from a converter inside a building is entirely separate and completely isolated from every other piece of wiring in the city or town, and that running a metallic

ground from one wire to the earth is not to be compared with grounding a positive wire by distribution from 75 or 100 volts, and in such cases should danger develop, being only on one wire, the lead fuse can give way to an excess of current on either positive or negative that in any way affected the other installation, and in such way give warning of danger whether in the converter or in defective wiring.

Regarding the distribution of currents over a large area, in discussing a system of running incandescent lights which requires us to use a little different apparatus, it seems to me that those of us who have the practical work to do are apt to lose sight of the fact that all the laws of wire and construction work which apply to straight incandescent or low tension wiring are not applicable to the alternating system and that all appliances which are made for straight incandescent work may be utilized for the alternating current by conforming to the laws which are now so well known regarding self-induction and the closed magnetic field, and it is a question to be decided by the electric light engineers in practice, to determine whether it is better to rely on high potential wires for a system of distribution and lay them out with as much care as the feeders, mains and systems are now laid out, and then to place the converters as near the lamps as possible—any way they may be required; or whether it is better to run a system of high potential mains and rely on your inside wiring, or your placing of your converters. By inside wiring I mean this—that in many plants converters are placed in groups, not necessarily in together and connected by a main trunk secondary wire which is

practically the same as the mains in a system of distribution, so that part of the advantages of the alternating system are lost in being able, in addition to the high potential wires, to run a complete set of secondary.

The example which our friend Mr. Slattery gave of the 400 light lamp taken from rough figures which I have in a note book only—it seems to me that I should arrive at a rather different result in this direction as the problem as it was given, as I understood it, was 400 lights, 16 candle power lamps, a mile and a half from the source of generation to the center of distribution, which it was suggested would require a number of Brown & Shaape wire, and with that number having 5 per cent. less. It may be that two methods of arriving at a result will introduce errors which hardly ought to be as great as this for assuming 5 per cent loss from the source of generation to the center of distribution and something like four or five per cent I believe was mentioned for loss in the converters independent of inside wiring, calling it a round ten per cent; 400 lights, and the lamps in more common use are something like a 50 watt lamp—400 lamps representing 20,000 watts to be delivered from the dynamo, and with the addition of 10 per cent for loss would give us 22.000 lights divided by the potential of the dynamo, giving us 22 amperes to be carried through this distance of three miles, and allowing our five per cent drop—5 per cent of 1,000 volts, being 50 volts, we have 50 volts lost. The 22 ampere current to be carried and the volts divided by the current gives us the resistance of 2 3-10 ohms which could be used in the line and for 3 miles of No. 5 wire

which would allow us—the wire having the loss of 3-10 ohms per thousand feet or about a No. 5 wire with a loss of 5 per cent.

MR. DECAMP: In the report read by Mr. Slattery he speaks more positively about the difficulty of insulating for this current. On the other hand he notes that the effect of the current upon a person—and he is corrobborated in this by Mr. Smith—is not as great as it is on the direct current. That struck me as being a little inconsistent. The electro-motive force, as I understand it, is a very strong element to guard against in making installations. It is what affects the human body. I would like to have an explanation of that.

There is another thing I would like to know. The peculiarity of this current is such that the close contact is going to affect the currents or going to affect the insulation, making it more or less difficult to insulate. As an explanation of why I want to know that, I would say that we are about to run an alternating circuit under ground in the city of Philadelphia through an iron conduit. Those are things we have got to contend with. Now, shall we make that conductor of an insulation that requires a second metallic covering such as lead? Do we lessen or do we increase our difficulties by so doing?

MR. SLATTERY: Right upon that point before we give any of the other matters that were brought forward any consideration, I would beg to refer to Messrs. Westinghouse who are in that line and who can render us some valuable information with regard to these special methods of insulation and I defer to them as having a far greater experience in that direction than I

have myself. If they will be kind enough to render the information which there is no doubt they are in possession of with regard to the disposition of such a circuit, I should be greatly gratified myself.

MR. SMITH (Allegheny County Light Company): I would state that I am not in any way a representative of the Westinghouse people though using their apparatus, but being in the same city as the manufacturers I have had exceptionally good opportunities for observing their work. In Philadelphia we are using lead and copper cables. We use that because it seemed to us in underground work that the first thing we had to look out for was moisture. We satisfied ourselves that if we could get a good metallic covering it would be probably about as good as anything we could get hold of. Our conduit in Philadelphia is made of a common pine box, in which the cable is laid, and the box is filled with pitch. In that we have iron junction boxes for connecting our feeder into our mains. The outside covering of the cable is not insulated in any way from the junction box, though of course the wire carrying the current is. In some parts of the street where we found it difficult, owing to water pipes the cable car conduits, and so on, to lay a wooden box, we used the iron pipe, through which we pulled these cables, and then filled them up with pitch. We filled them up with pitch simply as a mechanical protection to prevent workmen from hammering a pick into them. We have not had the slightest trouble or loss of current or induction or anything else. Our men handle the outer covering of this cable with perfect impunity, and as long as your dielectric is in good shape it seems to me you have

something that is perfectly safe. I understand that some experiments have been made by the Westinghouse Company with regard to this very question, and when I put to them the question, their answer was that we could use any kind of cable we wanted to as long as the covering was good, but for practical use they would recommend us in this particular instance a lead covered cable having both conductors in the one light covering; that is to say, two separate cables soldered together through their whole length.

And that is the form of cable I have been advocating myself for mechanical reasons. They made the test for me. They tested it thoroughly in every way and told me I would get perfect satisfaction out of it. When we turned the alternating current into our Philadelphia lead covered cable where the cables are run in separate boxes but grounded throughout their whole length the question was raised whether static charges would not come into effect and our men get shocks. But we did not find that there was any effect whatever. As to the question of loss of power through induction passing through a metallic covering it might be different with iron. As I say, I have had no experience with long conduits of iron, but it seems to me that if you run your wires close together that any effect you get on one wire when it is positive, would be neutralized the next instant. In the same way with telephone wires. We have found that if we cross our wires every four or five poles we have no effect whatever in the telephone. In one case we have the double circuit about 12 inches apart and the telephone wire running on top of the pole, about 7 inches between each wire.

There is a continuous musical note, but not nearly as annoying as the buzzing of an ordinary arc machine. We of course think that the telephone companies ought to cross their wires, but we do not think we ought to be called upon to be public benefactors to such an extent.

MR. DCAMP raised another point — I have forgotten it for the moment.

MR. DECAMP: On the question of the consistency of the statement that the——

MR. SMITH: Oh, yes. As regards that, of course I have only practical experience. The 50 volt alternating current you cannot feel. On the larger machines we are using, the discharge is not so heavy. You take an ordinary arc light machine and you have this immense mass of iron in the field magnet and when you open the circuit you discharge the field magnet into the line. That is the reason I think that the Thomson-Houston machine gives a so much heavier blow than any other. I have taken the discharge from the field magnets from an ordinary incandescent machine. It is a dead blow and there is a large quantity of electricity discharged at once, but in the armature of the ordinary alternating machine there is so little electricity in it that not much harm is done. We never think of shutting down the machine for the linemen to splice up. They climb up the poles and make the connections on live wires. They say they would sooner splice on our lines than on a Brush machine. We have had no case of the men being hurt with it at all. We had one of our men short-circuit a thousand volts with our switch boards with his plyers. It scared him and burnt the plyers but it did not damage either the machine or the man.

THE PRESIDENT: This discussion has taken a pretty wide range. What disposition will you make of the paper read by Mr. Slattery?

MR. SLATTERY: May I be permitted to say one word more? I would say simply that I believe the object of this report has been creditably obtained, in consequence of the very valuable information elicited from the companies who take a large interest and care in the introduction of this induction business throughout the country. It is extremely gratifying, too, the candid spirit in which the information is rendered. It is almost magnanimous in the manner in which it is given, and I cannot express my appreciation of it in too strong terms. Our friend Dr. Moses again has placed another future before us. He has given us apparently impossible problems to work out; but he has a singular prescience in his treatment of these matters, and I believe that the immediate future will show the realization of these apparently impossible accomplishments, as they have ably shown the accomplishment of apparently impossible things that in the past he has stated would be done. A gentleman at the end of the room made the statement about some miscalculation of a wire, and aired his erudition in that direction very creditably indeed. He debited me with the statement of a ten or fifteen per cent. loss in the circuit. I am not aware of stating any such loss in the induction system, and on reference to my paper he will be enlightened in that direction. The figures I gave there were simply approximate ones in regard to cost simply, and the loss that I stated was involved in consequence of using conductors, and the loss that he stated, was

entirely different—the calculations that led him to perform his mathematical gymnastic.

I have to again express my great appreciation of the manner in which our report has been accepted by this convention, and I know that I shall receive very great encouragement myself for future efforts in this direction in conjunction with our worthy and excellent opponents. (Applause.)

MR. KINSMAN: Since I came in I heard one or two gentlemen speak of the information they cared to supply in regard to this alternating system. I would like to add one thing that may be of interest. I have succeeded perfectly in burning an arc light with a 50 volt converter from the alternating system of the Westinghouse people. We get 12 hours from 24 inches of carbon, and a light that is perfectly steady.

MR. KIMBALL: Mr. President and gentlemen of the Association I wish to say that I owe Mr. Slattery an apology. In my haste I made a mistake which a better exercise of judgment would have prevented me from committing. I relied on figures that were scribbled on a piece of paper picked up from the floor and roughed over with a lead pencil, and I beg Mr. Slattery's pardon, as his calculations are correct.

MR. SLATTERY: I beg to accept your very graceful apology, sir. The per cent. of loss I stated in the paper I think was 4.

MR. SMITH (Allegheny County Light Company): I would like to ask Mr. Kinsman what is the style of the arc lamp.

MR. KINSMAN: It was the Simplex lamp, 2,000 candle, 55 volts.

MR. GARRATT: I move that the paper be accepted. The motion was carried.

THE PRESIDENT: The next paper is that of Mr. E. R. Weeks, of Kansas City, Missouri, on electrical education.

Mr. Weeks read the following paper:

ELECTRICAL EDUCATION.

Few questions of the day are so important as the applications of electricity, and there are none upon which exist such a lack of general information.

The telegraph business is so extensive that people think no more of sending a telegram than of posting a letter; we are beginning to depend upon the telephone as an every day necessity; the electric railway has demonstrated its financial basis; and the electric light, though a creation of yesterday, is so largely used, that about two hundred millions of dollars are invested in its manufacture in America alone. In fact, so many are the practical every day uses to which electricity is put, that we have not time to enumerate them. Yet the public has more knowledge of almost any other instrument of its convenience, than of this one force that first inspired the fear and curiosity of man. Not only is the general public almost wholly ignorant of the principles, uses and modes of application of electricity, there has been such a scarcity of those who have made a special study of these new branches of industry, that it has been well nigh impossible to secure the intelligent service that many of them require. A man of average education may easily gain the mechanical

dexterity, the sensitive hearing, and the rapidity of thought necessary for telegraph and telephone service; but some applications of electricity require thorough special training for efficient work, and we cannot hope for satisfactory service in the direction of traction and lighting till this training is furnished.

Electrical engineering is undoubtedly the occupation of the future for the young man who does not care to enter the already over-crowded professions, but whose education fits him for a broader field than that of the trades. It holds out the highest inducements financially, and it is a service in which the intellect can never rust out, as it offers a continually widening horizon of thought; indeed, the possibilities of this profession are as yet practically unlimited. In most fields of labor the best has been accomplished; here the work is in its infancy, and the demand is not only for skilled hands, but for trained and progressive minds. The property involved in the applications of electricity is already immense, and is rapidly increasing; much of the machinery used is most delicate—no unskilled hands should destroy its value or make it render less than its best service. "Electricians" to whom Ohm's law is "Greek," and "experts" who "adjust" but never clean, should not be allowed to multiply.

But how can the special education which shall produce true experts and electrical engineers be obtained? Several colleges have given this department some consideration, but not so much as it deserves. Its training should be both theoretical and practical. A thorough understanding of the theory of electricity is absolutely necessary to enable one to keep pace with

the rapid progress in this branch of applied science; and without an intimate knowledge of the apparatus used, commercial success is impossible. Colleges and universities should have well equipped laboratories, and should add to their curricula complete courses in electrical engineering, laid out after consultation with those few eminent electricians who have had experience in the class room, the laboratory, the factory, the station, and who know better than any school recluse what theoretical training is of value.

To receive the greatest benefit from such special courses, it would be well for the young man, after completing a thorough basic high school course, to spend some months in an electrical station doing the practical, every day work there required, and thus gaining a more nearly adequate idea of the information he will need to give him skilled control of the forces with which he is to deal. With this preparation, he will be enabled to take hold of the theoretical work with a zest that can come only from an understanding of what it is to do for him and what he is to do for himself. Having finished his college course, he is not yet to consider himself a graduated expert, but some time spent as a learner in factories and stations should be a regular part of his electrical education.

After fully carrying out such a plan, the young man will be in possession of a theoretical and practical knowledge of the work he has chosen, that will give him access to the most desirable of positions.

The more complicated electrical industries are of such recent date, and their growth has been so rapid, that school-trained workmen could not be obtained.

Schools had not had time to adapt themselves to the new order of things. Only unskilled labor could be employed, and only such can be had for some time to come. Much of this work has been performed by uneducated men, many of whom have shown that good results may be accomplished without school training or higher mathematics. Thoughtful observation and practical experience have done well for them, but always at the expense of costly mistakes and delays; and at best, such labor is limited in its possibilities. Only the trained mind can attain the highest places.

But something should be done to assist the vast army of halting hands that in the near future—nay in the very present—must do the work, while the schools are preparing for this new field of labor. Ours is not an industry with long years of experience to draw upon, yet it is one in which the unexpected, the unprovided for, is constantly occurring. Therefore interchange and comparison of thought and experience are more necessary here than in other industries of greater age or slower growth. Had this been fully realized in the earlier history of electricity, much of the bungling work of the past might have been avoided; for there can be no doubt that progress in intelligent service has been greatly retarded by the narrow policy which refused to impart information to the "new Man", but which is giving way before the broader influence of our associations. Members of the electrical fraternity are beginning to recognize the truths that knowledge given away is the more securely possessed; and that as all know more than one, all may be benefited by an

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interchange of ideas; and employers are awakening to the fact that they must also be educators.

In order that the skill and intelligence of the worker may in some wise keep pace with the rapid progress of electrical invention, every mode of improvement should be employed. The public should be informed upon these subjects and led to take an interest in them. Young men must learn that there is a new, broad and remunerative field of honorable and attractive service. The National Electric Light Association is doing much, and should do more, not only for the mutual advancement of its members, but to bring the business which it represents before the public in an intelligent way, not at all as an advertisement, but because it is safer, pleasanter and more profitable to serve a people well informed upon our work than one whose fears are multiplied through ignorance. The Edison Association and the Institute of Electrical Engineers are also exerting an influence in an educational way, and the clubs that are springing up in all electrical centers, cannot fail to accomplish a good work in the same direction.

But such organizations, however valuable they may be, can affect but indirectly the large body of men who handle machines and lamps, run lines or serve in any of the branches of a business that needs intelligence, even in its firemen. Yet these are the men upon whom the success of the new industry must largely depend.

As intelligent service is the most profitable, employers can afford to spare no expense to obtain it. Every station should possess a pleasant reading room well stocked with papers, magazines, and standard books on electrical and kindred subjects, and employees should

be made to feel it a part of their daily duty to inform themselves upon all matters connected with their work. From time to time, they should be questioned upon important points; and if they can not be led to do the necessary reading in any other way, they might have monthly grades and ranks determined by the information they have gained from their work in the reading room. All large stations should have mutual improvement societies of its men, furthered and assisted in a personal way by employers, in which the problems of daily work may be discussed, and directions given for useful and telling study by employees who do not well know how to help themselves.

Municipalities should appoint boards of examiners whose duty it should be to inquire into the competency of electrical employees, especially those of light and power companies, as ignorance and poor workmanship here endanger both life and property. Line and station foremen should be licensed, as their duties are fully as responsible as are those of stationary engineers.

By such legal measures, faulty construction will be prevented, and cities will secure safe and efficient service for the public; will further the interests of workmen; will protect electrical investments, and assist in the education of the people.

EDWIN RUTHVEN WEEKS.

MR. DECAMP: I move that the paper be accepted and spread on the minutes of the Association.

The motion was carried.

MR. SMITH (Jamestown, N. Y.): I would like to

ask if Mr. Weeks could recommend to the convention any practical text books which could be put in the hands of linemen for use in their every day duties.

MR. WEEKS: Yes, sir; I think there are a number of books which are sufficiently popular in their style to be of great use to employees. We have a society of our employees in Kansas City on the plan that I have pointed out here, and we have made it a complete success. I think that if Mr. Smith will get a list of electrical works from any one of the electrical papers that he will be able to select from 30 to 40 books, sufficiently simple and elementary to form a nucleus for a library of this kind.

MR. GARRATT: I would say in that connection that I find that the little work by Sylvanus P. Thompson, known as Elementary Lessons in Electricity and Magnetism, is a very valuable book and an inexpensive one, and contains enough material to keep the average workman busy for a long time.

MR. MASON: Is a motion in order at this time, sir?

THE PRESIDENT: Yes, sir.

MR. MASON: There is handed, me, sir, the following resolution which I have been requested to read. I will read the resolution and append another:

Resolved, That the work that was assigned to the committee on insulation and installation is of so much importance that this convention cannot allow the subject to escape their earnest attention; that the subject is of the utmost importance to the electric lighting interests, and one in which there must be abundant material and experience which can be obtained without expense to this Association, and further that another committee should be at once appointed to gather infor-

mation, classify the facts, and then offer them to the convention in form that may be of practical as well as of scientific advantage.

I add this resolution, sir:

Resolved, That a committee of five on insulation and installation be appointed to report at the next meeting, and that Dr. Otto Moses be the chairman of this committee.

I do not see the necessity of this second part beginning "that the subject is of the utmost importance." If I may I will omit that.

The first resolution was then adopted.

MR. MOSES: That is a very high compliment paid by Mr. Mason, but I must beg to decline.

MR. MASON: Does Dr. Moses refuse to serve on such a committee?

DR. MOSES: I do not refuse to serve, but I refuse to be the standard bearer when others are more competent than myself.

THE PRESIDENT: That shows a degree of modesty that does the gentleman infinite credit.

MR. MASON: That is entirely unexpected. (Laughter). I stated that it was unexpected, Mr. President, because I did not think you would allow any such declination.

THE PRESIDENT: Mr. Mason, you present a resolution that a committee of five be appointed?

MR. MASON: Yes, sir.

THE PRESIDENT: I find you retain Dr. Moses in the resolution.

MR. MASON: It does not lie with me to accept his resignation.

THE PRESIDENT: He has not been appointed yet.

The motion to appoint a committee of five was then carried.

THE PRESIDENT: I will appoint the committee and I will endeavor to induce Dr. Moses to serve on the committee, if not as chairman, as one of its members. With Col. Leggett's consent I will place him on the Committee on Revision of the By-Laws. There are two points which he made this morning and which I concede to be of the greatest importance—first, that the convention should decide where the next meeting of the Association should be held; next, that they should elect for President of the Association some one in the locality selected for the meeting, believing that rotation in office is a good thing. I have passed the time when I am seeking particularly after glory and would be very glad to resign the glory and labor to some more competent hands. In making up these By-Laws I think it would be well to consider that part of the proposition. The business of the Association can be better handled if the President of the Association is chosen from the location in which you intend to hold your next meeting. I assume, Col. Leggett, that you will serve on that committee.

MR. LEGGETT: I think inasmuch as I was cut off in my remarks this morning that it would be fair for me to say that as far as I am aware there could have been no better service rendered to our Association than has been rendered by our present officers and especially our present chairman; but it seems to me that it is a matter of considerable importance that these officers should be rotated for the special reason which has just

been mentioned by the chairman. The meeting in a certain locality ought to carry with it as nearly as practicable the election for that year at least of the officers of the Association in the same immediate vicinity and then again we might at some period be burdened with certain officers whom we do not like and through a sentimentality which might grow up in this way be burdened in a manner which we might not care to relieve ourselves of; while I am very happy to say, and I know I reflect the sentiments of every member of our society, that the present officers have served us with great ability, yet I think that that could be made a part of the constitutional ground work of our Association in order that no difficulty may arise or no embarrassment arise hereafter in the organization of our society or in its meetings. It was my purpose in speaking this morning to suggest that it be made an element of our-by-laws, of our constitution in fact, that the position of President and Vice-President—I think it ought not to apply to the Secretary and Treasurer, because their duties are of such a character that they may properly with great benefit be maintained in the same hands for a considerable period—but that the offices of President and Vice-President—that nobody be eligible to those offices for two successive terms.

MR. MASON: How can we have another election when we had one six months ago and the present officers were elected for a year?

MR. LEGGETT: In find no difficulty whatever in that, sir—

THE PRESIDENT: None whatever, sir. The present president will relieve you of that difficulty before the

end of the present session. I think it would be well to suggest in that connection at this stage that the committee on nomination and the naming of the next convention be appointed now, so that during to-day and the next two days they will be able to canvass that question thoroughly and suggest on the last day of the convention a proper place and the names of officers for the next meeting. To relieve them of any embarassment, I should as soon as that committee is appointed, tender you my resignation as president of the Association. This is done so as to facilitate the work we are engaged in now.

MR. LEGGETT: I want to add in that respect that this same matter was talked over by our present chairman and myself prior to the meeting in Detroit and it was his own suggestion and desire that that should be the course of our convention.

THE PRESIDENT: A thorough discussion of this question took place between Mr. Leggett and myself, and I believe that it is better that the officers of the Association should be subjected to some system of rotation. There is an honor connected with the holding of the office of president at least, and we all should be eager to fill that office. I have served my time over and over again and I would be very glad to hand the gavel to somebody else next year. I hope some gentleman will suggest a committee on nominations and place of meeting.

MR. MAILLOUX: I move that a committee be appointed by the chair for that purpose.

The motion was carried.

THE PRESIDENT: How many shall that committee consist of?

MR. MAILLOUX: I think that ought to be left to the discretion of the chair.

THE PRESIDENT: I will name Mr. Mailloux, Mr. Leggett, Mr. Robinson, Dr. Moses and Mr. DeCamp.

MR. EUSTIS: I would like to ask for information on one point, and that is that as I understand it, the election of officers is held once a year. Now the discussion has been on the subject of electing a presiding officer in the locality where the meeting of the convention will next be held. That same officer will hold office for two meetings. I believe the general practice of the convention has been to vary its place of meeting over different sections of the country. Now that same officer is going to hold his office for two meetings.

THE PRESIDENT: In the new constitution provision can be made to meet that point, so that you can have your elections semi-annually instead of annually.

MR. MAILLOUX: I beg to resign from the committee, my reason being that I am not perhaps well acquainted with the gentlemen who would be eligible for positions as officers; there are many other members of the society who know the prominent members thereof who would be more fitted for a position on that committee.

THE PRESIDENT: It will not take you long to get acquainted. I hope the gentleman will not press his resignation.

MAILLOUX: Very well, sir.

THE PRESIDENT: The chair is now prepared to en-

tertain a motion to adjourn until an hour to-morrow morning.

On motion of Mr. DeCamp the convention adjourned until 10 A. M. the following day.

SECOND DAYS' PROCEEDINGS.

The convention was called to order at 10.30 A. M., on August 10th, by Mr. Ralph W. Pope.

MR. POPE: I have been requested to call the meeting to order in the absence of the Vice-President, and it will be proper for you to nominate a temporary chairman to conduct the business of the meeting.

Mr. Frank Ridlon was chosen and took his seat as temporary chairman.

Lieutenant Murdock read the following paper:

THE ELECTRIC LIGHT OUTFIT OF THE NEW CRUISERS.

The question of how to best install the electric lights in the new men-of-war has been considered in detail, and it seemed advisable to bring the matter before the National Electric Light Association, that the manufacturers of the country might have the problem presented to their consideration, in advance of the time when they would be asked to act upon it. In conversation with managers of various companies, it has been impressed on my mind that the peculiar conditions existing on shipboard are but imperfectly understood, and as a natural consequence they have not as yet been

as satisfactorily met in this country as abroad. I am confident that American ingenuity and skill can fully meet our requirements and hope that the number of dynamos, about sixty, which will be needed for the vessels already authorized by Congress, may be considered as meriting the experiment necessary for their successful installation.

I am authorized to present in a general way the views of the Bureau of Ordinance of the Navy Department, on the peculiar conditions to be met, and on the best method of meeting them.

In men-of-war the prime requisites of all kinds of apparatus are compactness and lightness. Neither of these is of any material consequence in electric light installations on shore, and both are generally ignored. Attention has there been given mainly to the question of efficiency of conversion, and a glance at the advertising columns of any of the electrical journals shows that the maximum efficiency and best system of electric lighting is possessed by each of a dozen companies. Our conditions, so far as the dynamo is concerned, may be summarized as wishing the greatest electrical output for a given weight and bulk, and although at first thought this may seem to be essentially the same thing as efficiency of conversion it is widely different.

The following figures of well known American dynamos illustrate this point. The comparison is made on the basis of "watts of output per pound of dynamo." The weights, speeds and electrical outputs have been obtained in general from the manufacturers, and are given, of course, only approximately. In this comparison it is, of course, necessary to consider also the sizes

and the number of revolutions, the watts per pound increasing with large machines and high velocities.

Dynamo.	Revolutions.	Watts in Exter. Circuit.	Watts per lb.
Edison No. 20, - - - - -	800	50,000	6.0
Brush H^3 - - - - -	850	66,000	9 4
American 50 Lt. - - - -	875	21,600	5·7
Westinghouse No. 18, - - -	900	30,000	5·4
Hochhausen No. 8, - - -	1000	35,200	8.8
Mather, 500 lights, - - -	1050	35,250	7·4
Western O. W. I., - - -	1050	11,500	4.1
Brush G^4, - - - - -	1050	28,300	9·3
American 15 Lt. Arc, - - -	1075	6,480	4.8
Western 7 W. I., - - - -	1100	20,125	6.5
Westinghouse No. 12, - - -	1100	18,000	4.
Brush F^5, - - - - -	1100	19,000	8.5
Thomson-Houston HI, - - -	1150	25,600	6.1
Edison No. 12, - - - -	1200	30,000	6.9
Hochhausen No. 6, - - -	1200	17,600	8.
Thomson-Houston EI., - - -	1250	13,200	5.8
Mather 400 lights, - - - -	1300	28,100	7.0
Edison No. 8, - - - -	1400	20,000	6.9
Thomson-Houston C. I., - -	1500	6,000	5.6

The next consideration is that of the connection of the dynamo to its engine. A starting point is afforded in the rule that belting should never be used on a sea going vessel. Nothing so radically violates our condition of economy of space as the use of belting. Where space is saved by the use of a short belt, the working conditions are comparatively unsatisfactory. Belts are liable to be thrown off by the sudden changes of load to which our dynamos are subject, and become a source of danger to the attendants if the ship is rolling heavily. The adoption of friction gearing between engine and dynamo has been suggested, and is proba-

bly practicable, but its durability on shipboard, where the motion of the vessel must cause working of the two shafts, may not be great. In the navies of Europe the practice of direct connection is universal, the dynamo shafts being coupled to that of the engine. This calls of course for either a great reduction of the speed of the dynamo or a corresponding increase of that of the engine. It is easy enough to procure an engine running 1500 revolution per minute, but it is a very difficult matter to find one which will govern satisfactorily at so high a speed. So far as I can ascertain there is no automatic engine manufactured in the United States, capable of indicating thirty horse power which is designed for a higher speed than 400. I have been informed, however, that some of the types now in the market could be modified so as to operate well at 500. I am not aware of any dynamo in the United States absorbing 30 horse power, which would yield its normal outputs at even the higher speed. It is much easier to reduce the speed of the dynamo while preserving its electrical outputs than to raise the speed of the engine. Admitting the desirability of direct connection on shipboard, the problem proposed is the best method of obtaining the same output in watts per pound, as speeds below 500 that are now commonly obtained between 1000 and 1500.

The following figures of European dynamos obtained in the same way as those already given for American machines, and probably equally accurate, will show how this problem has been met abroad:

Dynamo.	Revolutions.	Watts in External Circuit.	Watts per lb.
Manchester No. 6,	350	9,000	3.6
Victoria H^3,	350	36,000	9.7
Siemens & Halske,	350	16,000	8.1
Edison-Hopkinson 10 in. long,	350	16,800	2.9
Manchester No. 7,	400	22,500	4.6
Victoria F^3,	400	21,600	8.6
Siemens & Halske,	400	20,000	10.2
Edison-Hopkinson, 15 in. short,	420	39,600	3.4
Gramme H^{2}d 225,	450	23,600	8.3
Elwell-Parker,	450	50,000	5.6
Crompton 40-110 J,	460	45,100	6.7
Edison-Hopkinson 8 in. long,	525	15,400	3.3
Manchester No. 5,	525	6,500	4.7
Crompton 22-110 J,	550	24,750	6.0
Manchester No. 6A,	550	25,000	6.75
Edison-Hopkinson 10 in. long,	550	25,200	4.4
Victoria D^2 S,	600	8,400	6.7
Gramme HIc 200,	600	14,000	6.4
Ganz,	670	50,400	9.2
Crompton 60-110J,	675	66,000	9.8
Goolden-Trotter,	765	16,000	6.2

It is necessary to only refer incidentally to a few of the methods by which these results have been obtained. The principal are the elimination of all iron not needed for the magnetic circuits of the dynamo, and the adoption of a type in which this circuit furnishes a framework of necessary rigidity. The magnet arcs should be of the best wrought iron, this single condition frequently reducing the weights twenty-five per cent, while preserving the output. Armatures of large diameter give high peripheral velocity at low speeds, and this seems to recommend the Gramme ring, a large drum armature being cumbersome. The Gramme form has another advantage for ship's use, that it can be repaired

or even renewed with the facilities existing on shid board, although I believe a Siemens' winding has recently been perfected, which admits of equal facility of repairs. The use of multipolar machines contributes to lightness and the Siemens & Halske machine referred to in the preceding table has four field magnets inside a Gramme ring. Flattened ring armatures and multipolar magnets also give large output for the weight.

Every ship, aboard which the electric light is a necessity, should have two similar dynamos, that either may be used at will. At present this precaution is not observed in the navy. The lighting of the ship by incandescent lamps is under the control of the Bureau of Navigation, and the installation for this purpose consists of an ordinary plant of an engine driving a dynamo by belting. The electric search lights, two of which are furnished to each large vessel, are supplied by the Bureau of Ordnance, the installation for this purpose consisting of a Brotherhood engine driving two C Grammes connected direct in the same bed plate. In case of accident, the incandescent dynamo will not work the search lights to advantage, nor will the Grammes operate the incandescent lights well. This is, of course, most unsatisfactory and the need of the service is for a dynamo which will perform either work well, and if necessary both at once. Our search lights require about fifty volts and fifty amperes for ordinary work, the current being sometimes increased to one hundred. The lamp is operated by hand in order to fully utilize the radiation from the crater of the positive carbon. The hand lamp and Mangin projector are in use in nearly every navy in the world, for projecting

a condensed train of lights to a distance. Automatic lamps do not admit of continuous adjustments as readily as the hand lamp, and are not so thoroughly under the control of the operator. In any search lights the arc may sometimes fail, and it is sometimes advisable to cut the lights out without notice. Large and sudden variations of lead are thus liable to occur, and these should not affect the dynamo. It is unquestionable that incandescent lights can be worked from a series dynamo and search lights operated by a shunt machine, but both of these proceedings are makeshifts. It is undeniable that both search lights and incandescent lights can be worked satisfactorily by a compound dynamo. I have been called upon to work all three kinds of dynamos for each purpose, and the compound dynamo works incandescent lights as well as a shunt machine, and search lights better than does the series machine supplied for the purpose. I have also worked two search lights and fifty incandescent lights simultaneously from one compound dynamo. Each search light had three-tenths of an ohm dead resistance in circuit to bring the differences of potential down to about fifty volts. There is nothing new in this, but I have so frequently been asked what advantage the compound dynamo possessed, that I have trespassed somewhat on the time of the Convention to give reasons for the opinion that all naval dynamos should be compound wound for a constant potential.

It is probable that many new vessels will require electric moters. Some of our gun carriages may be worked in this way, on account of the advantages that

our electric motor offers in small weight and bulk, and in the important fact that it is so much easier to splice a broken main than to patch a leaky pipe when steam or compressed air is used for power. Electric motors will be useful for shell twists and ammunation whips, reducing the number of men employed for these purposes. Here also light weight and compactness are absolutely essential, and nine tenths of the motors and commercial use would be barred out as too heavy. A ten-horse power motor, the largest we would possibly use should not weigh over five hundred pounds.

The potential at which the mains should be kept must be determined from the relative importance of the three uses to which our dynamos will be put. As we are not bothered by the question of long distance transmission, we can well use a low potential for incandescent lights and motors, while search lights require only 50 volts, although it is advantageous with any dynamo to have a little dead resistance in the search light circuit. For these reasons I think seventy volts is about the best point for a compromise. This is the voltage used in the French navy, the English working at eighty. If two search lights can be successfully worked in series, the potential at the dynamo might advantageously be raised to one hundred and ten or even one hundred and twenty volts. Experiments have been made to test this point, but are not decisive as yet. Should there, however, be any material advantages secured in the working of either incandescent lights or motors by the use of a high potential, the search lights could be operated with sufficient resistance to give them their proper potential.

The same requirements of small bulk, and weight must control in the choice of engines. The adoption of a compound dynamo throws extra responsibility on the engine as without constant speed the advantages of the dynamo are not apparent. American automatic engines can easily meet this demand, but most of them are too heavy, rigidity of frame being secured by unnecessarily large masses of cast iron. One hundred pounds weight per indicated horse power with 80 lbs steam is a liberal allowance. In many European engines, steel and phosphos bronze have been largely used to obtain lightness.

It may be interesting to compare a few well known dynamos as to compactness, the comparison being made on watts of output per square inch of floor space.

Dynamo.	Revolutions.	Watts in Exter. Circuit.	Watts per sq. in. floor space.
Manchester No. 6,	350	9,000	4.9
Edison-Hopkinson 10 in. L.,	350	16,800	6.9
Manchester No. 7,	400	22,500	6.0
Edison-Hopkinson 15 in. Sh.,	420	39,600	9.1
Crompton $\frac{40}{110}$ J.,	460	45,100	20.3
Edison-Hopkinson 8 in. L.,	525	15,400	6.5
Manchester No. 5,	525	6,500	4.6
Ganz,	670	50,400	20.9
Crompton $\frac{60}{110}$ J.,	675	66,000	26.4
Edison No. 20,	800	50,000	8.8
Brush H^3,	850	66,000	23.5
Westinghouse No. 18,	900	30,000	5.8
Hochhausen No. 8,	1000	35,200	15.0
Mather 500 lights,	1050	35,250	8.5
Weston 6 W. I.,	1050	11,500	4.4
Brush G^4,	1050	28,300	17.7
Weston 7 W. I.,	1100	20,125	5.4
Westinghouse No. 12,	1100	18,000	4.7

Dynamo.	Revolutions.	Watts in Exter. Circuit.	Watts per sq. in. floor space.
Brush F^5, - - - - -	1100	19,000	15.3
Thomson-Houston H. I., - -	1150	25,600	9.0
Edison No. 12, - - - -	1200	30,000	7.7
Hochhausen No. 6, - - -	1200	17,600	13.3
Thomson-Houston E. I., - -	1250	13,200	8.2
Mather 400 lights, - - -	1300	28,100	7.3
Edison No. 8, - - - -	1400	20,000	6.0
Thomson-Houston C. I., - -	1500	6,000	5.9

As illustrating the advantages of direct connection in economy of floor space and also of weight when care is taken, I have a few statistics of ship installations.

	Plant.	Connection.	Total Wt.	Floor space square ft.	Wt. per 16 c.p. lamp.	Sq. in. of floor per 16 c. lamp.
U. S. St'm'r Chicago.	2 Edison No. 8 (200 lts.) 2 Armington & Sims.	Belting.	16,000		40	
U. S. St'm'r Boston.	1 Brush Compound (150 lts.) 1 Straight Line.	Belting.	10,400		70	
U. S. St'm'r Atlanta.	1 Weston 7 W. I. (150 lts.) 1 Armington & Sims.	Belting.	6,500	105	43	101
Steam Yacht Alva.	1 Siemens' Compound (160 lts.) 1 Willans' Engine.	Direct. 450 Revs	6,700	27	43	24
Fr. Ironclad Indemptable.	2 plants each. 1 Multipolar Gramme (160 lts.) 1 Vertical Compound Engine.	Direct. 350 Revs	7,040	29	44	26
Torpedo Station.	1 Brush No. 7 Special (100 lts.) 1 Westinghouse.	Direct. 700 Revs	4,000	17	40	25
Torpedo Station.	1 Weston No. 8 Special (220 lts.) 1 Westinghouse.	Direct. 390 Revs	9,300	75	42	41

The preceding show a general average of about forty pounds dead weight of dynamo and engine for each

sixteen candle lamp, whether high or low speed dynamos are used. In the following, special attention has been paid to to the manufacture of light and compact apparatus.

	Plant.	Connection.	Total Wt.	Floor space square ft.	Wt. per 16 c. lamp.	Sq. in. of floor per 16 c. lamp.
	1 (200 lights) Brush Compound.	Direct.	5 500		27½	
	1 8 in. Brotherhood.					
Steam Yacht Restless.	1 Arnold Dynamo (30 lights.)	Friction.	600	6	20	29
	1 Vertical engine.					
	1 Goolden Trotter Dyn.(75 lmps)	Direct.	900	5¼	12	11
	1 Tower engine.					
	1 Victoria Dynamo (60 lights.)	Direct.	800	4 6/16	13	11
	1 Brotherhood.	765 Revs				
Ital. Cruiser Dugali.	1 Parsin's Dynamo (150 lights.)	Direct.				
	1 Parsin's Steam Turbine.	9000 Rvs	900	6¼	6	6
	(3 plants like above.)					

It is noticeable abroad, that with the type of slow speed dynamos established in the market, the system of direct connection is adopted in many isolated plants on shore. The tendency throughout Europe is to reduce the speed of dynamos, preserving the electrical output by a careful study of details. Few recent machines built abroad are designed for higher speeds than 800, while an American company operating at and above 850, advertises slow speed as one of the advantages of its dynamos. In this country the naval demand for slow speed dynamos will be comparatively

small, but if it serves to introduce the type into the market, I am satisfied from what has taken place in Europe, that the system of direct connection will create a field for itself, as soon as the apparatus can be procured without the heavy expense attendant on special work. It recommends itself in any installation where either weight or floor space is to be economized. I believe it can be successfully utilized in lighting railroad trains, especially if in the near future railroad companies have to furnish steam for heating purposes. Plants could be furnished small steamers and yachts, in which a common installation could not find room.

There are one or two other considerations governing ship installations. The principal is the absolute necessity of high insulation. The Bureau of Navigation has in its recent contracts called for an insulation resistance of one thousand megohms per nautical mile, after twenty-four hours immersion in salt water. Lead covering is also required as a protective against mechanical injury. We are so exposed to short circuiting and corrosion from salt water that the high standard called for is most wise. All switches, junction and safety boxes, and in fact all parts of the circuit should be thoroughly insulated. Difficulty has been experienced from salt water running along the wires into lamp sockets, short circuiting the lamp. The insulation of the whole circuit is sometimes required to be at least one thousand ohms for each volt at the terminals of the dynamo.

LIEUT. J. B. MURDOCK, *U. S. Navy.*

LIEUTENANT MURDOCK: One or two things

occurred to me while reading the paper. Things which are necessary in marine installations are measuring instruments both ammeters and volt meters which are independent of both gravity and magnetism. We want some kind of an instrument like a dynamometer, perhaps, or something of the kind which would be independent of the earth's magnetism and would not be affected by the local magnetism of the ship. Another thing which is necessary is the independence of the needle of the effect of the rolling of the ship. This has been already met by Sir William Thompson in his marine galvanometer and I think in some recent instruments which I have not yet seen. The simplest way apparently is to suspend the magnet or needle or coil by a suspension which passes through its center of gravity. If this is accurately done, of course the force of gravity has no moment to act upon and the rolling of the ship does not offect the needle at all.

I was requested to present those facts to the consideration of the convention, and I have to express my thanks for the courtesy extended in affording me the opportunity to do so. (Applause.)

Dr. Moses: I listened with great pleasure to that very interesting paper and as there are some points in it which are of very great interest to a large class of our nomadic population, I would like to ask some questions of Lieutenant Murdock in regard to some statistics which he has omitted. Would he kindly let us know whether he has gathered any information as to the relative methods of laying wires on board ships; that is, are grounds used. Is the hull of the ship used as one

of the conductors, or is there a tendency to have the circuits entirely independent of the ship itself?

LIEUT. MURDOCK: In England, I know, they use what they call the ship-return, or as they prefer to put it, the one-wire system, but I do not think anything of the kind has been used in this country and I should think it highly objectionable. All the installation required to be put in is protected by the highest attainable insulation—a double circuit and every part insulated. The system of earth connections has been used for quite a long while in torpedo service. Much of the torpedo apparatus in the navy has until within the last few years been arranged to work with the earth, but premature explosions have taken place and that has been discarded. Today, as far as I know, all plants are installed with two wires and high insulation.

MR. KINSMAN: I would like to ask the gentleman if he knows anything about the experience of the steamship "Alaska." They were at one time giving the one-wire system a test.

LIEUT. MURDOCK: No, sir. I know they are using the one-wire system on Mr. Vanderbilt's yacht, the Alva.

MR. KINSMAN: I thought they were experimenting with it with the view of putting it on other steamships.

DR. MOSES: I was crossing in the steamer Bourgogne of the Compagnie Transatlantique and we had made a very rapid passage and everything was very lovely, when about four hours from Havre people began to be disturbed because the previous ship, the "Champagne," had been run on the rocks at about that distance from Havre. We were talking of the matter

and all of a sudden we saw a stir about the ship and found the captain and one or two officers disappear and we all made a start to find out what was going on. We found about 20 feet of the molding smoking heavily and the firemen were at work tearing it down. When we got there, we found there was the beginning of what might have been a serious fire; it was started by the defects that Lieut. Murdock spoke of in the insulation. It is the hardest thing in the world to keep an insulation on a sea line. All of you who have houses at the sea shore will have noticed that where the verandahs or piazzas are painted with metallic paints that there is a tendency to a decomposition by the chlorides of the sea air attacking the carbonates, decomposing them and making them soluble as chlorides of lead or zinc and you have the wood towards the sea and the rest of it nicely painted. If you want to make a good paint for a sea house use the worst paint you can get—that is carbonate of baryta which would not be decomposed. All these insulations are affected by the chlorides that come from the salt breeze. In this particular case I took occasion to inquire into the subject. The hull of the ship was used for the return wire and when I inquired into it—although the crew and officers were very well disciplined and very reticent, I found they were always on pins and needles for fear fires would break out. Further investigation led me to find out that there had been a previous accident of the same kind, and although it looked very pretty it is a highly dangerous thing and we ought in some way or other to protest against it, because those accidents, if they occurred in times of danger when

people would be compelled to take to the boats and the decks would be yawning, would be accompanied by twenty or thirty feet of fire combined with the other horrors. We ought therefore to protest against such a thing; by such a paper we do so in the best way.

MR. MAILLOUX: I would like to ask Lieut. Murdock a question relative to the number of hours during which the energy is to be employed on board ship—whether the time of use will be pretty well distributed over the 24 hours of each day or whether there will be parts of the day when the source of energy will be at rest, not being used.

LIEUT. MURDOCK: I suppose that ordinarily the incandescent light burns all night from before sunset until after sunrise. In some of the vessels, as in the monitors, I imagine the incandescent circuit may be partially used all the time. (The remainder of the speaker's remarks were inaudible to the reporter.)

MR. KINSMAN: I would like to ask the gentleman another question, and that is as to the average light of the incandescent lamps on board ship as compared with that on *terra firma*.

LIEUT. MURDOCK. I think there we work with a large factor of safety. They generally run them low. I have only been on board one vessel installed with the electric light. I found that 16 candles gave sufficient light when burned at 13. When a vessel is going on a long cruise it is a great advantage to save the lamps. I think in almost every case on a man of war the lamps will be burned under power.

MR. KINSMAN: Do you think life would be as long under similar circumstances ?

LIEUT. MURDOCK: I think so, yes. As far as the lighting is concerned, the only difference is in the vibration, and there may be some kind of carbon that would not be effective. If the carbon was elastic and people would stand the vibrations and especially if the lamp were put on a spring socket I think the lights would last as long as a good installation ashore. The discharge of heavy ordnance in the case of the Atlanta, broke not the carbons, but the lamps. The lamps were left in the sockets in some cases to test them, and the glass itself was fractured. When the glass goes it is no use to try to protect the carbon.

MR. RECKENZAUN: I should like to ask Lieutenant Murdock whether he has tried Ayrton & Perry's meters on board ship. Those meters are protected by an iron shield which renders them independent of any magnetic influence. There is no necessity for the meter to be put perfectly level upon any table on any particular spot where the measurements are taken.

I should like also to point out in connection with this subject that in British men-of-war it is the tendency to use the double wire system because by using the ship's side as a return there is a large liability for leakages as pointed out by Dr. Moses.

LIEUT. MURDOCK: I have not been able to use the spring meter on board ship. With a Cardew voltmeter the needle would vibrate about four volts, and with the Ayrton & Perry ammeter it seemed to me to vibrate about the same number of amperes. I don't know of anything in the market to-day better—(remainder inaudible.) I believe in the British Navy they have been using a portable form of Siemens dynamometer

and some of them have been ordered here in order to test them.

DR. MOSES: I am sorry to trouble you again, but there is some further information I would like to elicit. Signalling, I presume is a very important thing on war ships, and it is very necessary that you should be able to use both small and large lights. Now, is it your experience that a 100 or 110 volt circuit is adapted to the use of arc lights, or would it not be preferable to have a 50 volt circuit on board ship so as to be able to use your arc lights directly in multiple arc?

LIEUT. MURDOCK: I have recommended in the paper 70 volts. Of course our experiments with these search lights have been going on a great many years and the general tendency seems to be that at least a tenth of an ohm dead resistance has a very steadying effect on the light, no matter whether we use a hand lamp or an automatic lamp. A little dead resistance seems to give us better working. The search lights are used so seldom and our general method of working is so economical that we do not care for the energy we waste in these dead resistances. The search lights themselves are of French manufacture, though I think the Brush Company of Cleveland have made essentially the same apparatus. I must confess, perhaps, to a little disinclination to use an incandescent lamp at 50 volts. I would rather take a little higher potential and work a lamp about 4 watts per candle and try to get more light in a shorter time.

DR. MOSES: Have you ever visited the installation on board the United States Fish Commission Steamer "Albatross?"

LIEUT. MURDOCK: I am familiar with the details but have never been on board the vessel. They use the old Edison B lamp. Of course if we want to take a B lamp with 55 volts we can do it better than with a 16 candle lamp of the same potential.

DR. MOSES: On a recent visit to Pittsburg I saw everywhere an installation of 50 volt lamps. It appears that the Westinghouse Company of Pittsburg have adopted that as a standard. Their reason for adopting it, as I am told, is on account of the economy of the lamp. They get fewer watts per candle power. That it seems to me also permits of the use of arc lights directly in the circuit. Incandescent light people, as a rule, neglect the arc lamp and arc light people neglect the incandescent light. It seems to me there should be an imitation of the harmony that prevails here and they should unite in one system the advantages of all. Arc lights should be used with incandescent lights, and yesterday some one, I think Mr. Smith of Pittsburg, suggested that an arc light can be used direct from converters. If Mr. Smith is present he will confirm or deny it but I presume it must have been on a 50 volt circuit.

MR. SMITH: It was Mr. Kinsman of New York who mentioned that. It was news to me.

MR. KINSMAN: Some seemed to question the ability to run on very high voltage. They asked me if it was possible, after the adjournment. I have run them equally well on 100 volt converters. Fifty volts are, however, desirable.

MR. DECAMP: May I ask if there is any loss of current in running it on a hundred volt current?

MR. KINSMAN: They are obliged to lose some. I have not the data with me. We have reduced it very much from what it was a few months ago and we hope to eliminate the whole of it and I think we shall very soon. One of those lamps that I spoke of I operated with less than a quarter of an ohm's resistance.

DR. MOSES: The discussion brings up such facts as have occurred to me that will answer some of the points that have been raised and some of the questions asked. I happened to have made the first experiments on board the steamship "Albatross" that I spoke to Lieut. Murdock about, with the use of an arc light on incandescent light circuits. It was a 55-volt circuit. It was a lamp directly in the circuit and one that was operated by a function of the current and the lamp was invented to run on incandescent light circuits. While there it was found, after a great many experiments, that there was a normal length of arc. You may, of course, draft lamps for any voltage, but it is found by experience, taking carbon in its chemical composition and the tendency to an extinguishment of the arc, that a certain length of arc, perhaps from an eighth to a quarter of an inch is best adapted to arc lighting. For that reason it is necessary to have about 45 volts between the terminals of the lamps, and if you are running a 55-volt circuit it gives you that limit of loss which enables you to run out to any length right from the incandescent circuit on the ship. In this particular case there was about one eighth of ohm put in. It worked very satisfactorily. There was no winking of the lamps at all. The lamp itself was invented for a 55-volt circuit; but the difficulty of putting lamps in series on a multiple

arc curcuit is so great that it is not advisable. Therefore, the adoption of a 50 or 55 volt standard enables us to harmonize the arc and incandescent light in a most remarkable way. You can use your lamps directly from the circuit and there are places of course no one will deny where an arc light is far superior to an incandescent light. It gives you five times as much light per pound of coal burned and for large spaces it is very much more useful; so that it will be very desirable to adopt some general system where arc lighting and incandescent lighting could harmonize.

MR. KINSMAN: The lamp that I have reference to has been wound so that we have successfully burned two lamps, that is multiple series, on a 110 volt current. I have not the slightest doubt but that can be successfully done by the lamp in a very short time. That brings the thing down to a commercial basis and under all conditions.

DR. MOSES: But you must use two lights together. If you only have one you are compelled either to throw your superfluous power into resistance or into the light that is in use.

MR. KINSMAN: In general installation, we are not going to put up two lights where they are not needed. Where there is only one light we keep it in that way.

MR. WRIGHT: Lieut. Murdock speaks of one of the requisites for ship installation being the settlement of the voltage. I think that difficulty is entirely overcome with the alternating current system, as we can supply a converter to give you any voltage you please from our secondary wires.

LIEUT. MURDOCK: I am very glad Mr. Wright

suggested that. I think there is one objection to the alternating current on board ship and that is for search lights. Our hand glass is rather a peculiar institution. The carbons are inclined at an angle and placed out of the line, the positive carbon being uppermost, so that the crator is turned toward the mirror.

MR. WRIGHT: I think there will be no very great difficulty about that.

LIEUT. MURDOCK: As most of the light is given off from the end of the positive carbon in a continuous current , I fear that in an alternating current system we lose this advantage. As we are trying to get a system which will use either arc or incandescent lights from the same dynamo, the alternating current in this respect does not seem so good. I do not know that I fully comprehend Dr. Moses, but in the system I speak of we work our arc lamps parallel with each other just the same as we put in an incandescent lamp.

DR. MOSES: I would state more fully then, that it is desirable, of course, to run an arc lamp exactly like an incandescent lamp since the function of the arc is such that it is equivalent in a certain ratio to the constant resistance of the incandescent lamp if you only give it time to act. The arc is a constant for every voltage, so that if you use a multiple arc arrangement and you have a 50 volt circuit, since the arc for a 50 volt lamp is best adapted for arc lighting, it is advisable to use the 50 volt circuit for that purpose, putting two lamps in series or to throw in a considerable amount of resistance if you use a 70 volt circuit, as you suggested.

I would just say there were some experiments carried on by Captain Tanner and myself on the Albatross for

the purpose of using a search light. In fact, we used this arc light as a head light going around Wilmington, and found in a storm that it worked very well, but an arc light can be used on an alternating current, and if you use it for a search or signal light the alternating current presents peculiar advantages. You have your reversals of current and you can make your flashes and signals come in with your alternations of current. You could alternate the flashes very nicely in an alternating system.

MR. KINSMAN: I would like to ask Lieut. Murdock if he has any difficulty in the feed of the search lamp and what the nature of the difficulty is.

LIEUT. MURDOCK: I am afraid if I go into that I shall have to describe the lamp.

THE CHAIRMAN: Gentlemen, we shall have to cut the discussion a little short as there is one more paper to be read this morning. What disposition will you make of this paper of Lieut. Murdock's?

MR. PHELPS: I move that it be accepted with the thanks of the Association, and entered in the proceedings.

The motion was carried.

THE CHAIRMAN: I am very sorry to inform you that I held in my hand the resignation of Mr. Morrison, President of the National Electric Light Association—something that I did not expect.

DR. MOSES: I moved that it be indignantly refused.

The motion was numerously seconded.

THE CHAIRMAN: All those in favor of accepting this resignation say aye.

MR. DECAMP: That is not the question. Dr. Moses resolution was seconded.

THE CHAIRMAN: All those in favor of refusing to accept the resignation of Mr. Morrison will please signify by saying aye.

The motion was carried unanimously.

THE CHAIRMAN: The next business before the meeting is the report of the committee on By-Laws—Mr. A. J. DeCamp.

MR. DECAMP: That will have to be made a special order for some future meeting. The committee is not prepared to report. They have formulated their report but it was very radically changed from that report which was made yesterday and we propose to get it printed and distributed among the members that they may be prepared to disuss it when it comes up. I would therefore move, if it does not interfere with any of the other arrangements of the Association, that it be made the first business in order tomorrow morning.

The motion was seconded.

MR. STEUART: I would also suggest that it might be well to make some provision in view of the special order made for tomorrow morning by the motion yesterday. The discussion of Mr. Garratt's report has been made the special order for the first thing tomorrow morning. It might be well to give this precedence.

THE CHAIRMAN: The motion is that this matter be made the first thing in order. Are you ready for the question.

The motion was carried.

Mr. Calkins on behalf of the committee of arrange-

ments made some announcements with reference to the excursion.

THE CHAIRMAN: I have also an invitation here from Mr. Meigs, of the Elevated Railway, East Cambridge. I have also an invitation from the New England Telephone & Telegraph Company to visit their works and asking us to designate a time when any or all the members will make this visit.

The next paper is by Dr. Waldo on instuments for bending tests of line wire.

Dr. WALDO: If you will excuse me just one moment I should like to go into the lobby and get that little instrument.

While Dr. Waldo was absent from the room Mr. DeCamp spoke as follows:

Mr. Chairman, while you are waiting I would like to lay before you a communication which is a matter of information. It is not information growing out of any official action of this Association, but it is a matter with which you are all more or less familiar and several questions have been asked me in reference to it. The Secretary will please read it.

The Secretary read as follows:

"The committee of the Association of Electric Light Companies for mutual protection against exorbitant prices of carbon, after careful deliberation on the subject disire to announce that in view of the collapse of the lete carbon combination and the unsettled condition of the market it is not deemed advisable at present for the Association to take further action toward establishing a manufactory or the concentration of a large number of contracts for carbon, believing fully that the individ-

ual companies will experience no difficulty in placing their orders at fair and satisfactory prices."

W. S. FREER, *Secretary.*

The Secretary read the resignation of Mr. Charles Cooper as Treasurer of the Association.

DR. MOSES: I would like to repeat the same resolution that was offered with regard to our President, were I not forbid from doing so by Mr. Cooper himself, whose great good sense suggests—and I should lay it before the convention in his words—that the Treasurer should naturally be in the neighborhood of the President, because it frequently happens that the President is not aware of the deficiencies there may be in the Treasury and orders are frequently given for sums greater than the condition of the Treasury would warrant. Therefore it is desirable that he should have at his elbow some one who can tell him the balances, and, therefore, I think it is eminently proper—well, I will not anticipate a resolution that will appear later before the convention, and may close by offering our thanks to Mr. Cooper for the efficient way in which he has conducted the office.

THE CHAIRMAN: Gentlemen, you have the resignation of Mr. Cooper now before you. What action will you take?

MR. STEUART: I move that it be accepted with thanks. (Laughter.)

MR. STEUART: That may need some explanation. I have no intention whatever of thanking Mr. Cooper for resigning, but only for the very excellent service he has given in the past.

Mr. Steuart's motion was then carried.

DR. WALDO: Mr. President and members of the convention: In looking over some specimens of wire which were sent to the Baltimore & Ohio Telegraph Company, Mr. Maver and I were very much impressed with the uncertainty of the bending test of line wire. Very simple devices are oftentimes very advantageous in use, and I thought it might be of interest to tell the convention of a simple tool which will give more or less uniform results in the bending tests. The objection to taking a piece of wire in your hand and bending it, as is ordinarily done, is this—that a piece of wire bent at an angle here (illustrating) will break, not in proportion to its strength or its value as a wire, but in proportion to the diameter of the wire and its crystalline structure. A very hard drawn wire, for instance, will break with much less bend around a sharp angle than around an angle of its own diameter. I noticed that in all the tests described by the division of postal telegraphs in England, Mr. Preece is careful to insist that the wire be bent around its own diameter. Any of our hard drawn coppers will break after one, two or three bends. The little instrument which Mr. Maver and myself constructed is merely a pair of plyers which can have a pin of different sizes inserted at its center of motion and will grasp the wire uniformly and it is meant to be screwed to a board so that the angle at which the wire finally breaks on the last turn is accurately shown. I think as the mechanical properties of wire come more and more into consideration and become more and more desirable, as they rapidly are becoming, that it is extremely important that we have

a uniform system for this bending test, and I do not know of any better condition than that the wire shall be bent around its own diameter—a pin of its own size held by some such instrument as this and that the number of degrees that it takes on its last turn shall be registered. For instance, we know that a wire will take three right angle bends and we will say fifty degrees more. You can make any simple arbitrary convenience as to to the number of degrees of bending that a wire will stand, and as many of our wires will break at a single bend or bend and a half, it is very important that we keep the last number of degrees which the wire bends in order to have any indication of the mechanical value of these high grades and hard drawn copper conductors. This little instrument will lie in the office of the Electrical World. It is very crude; it is the first one that was made. Of course the next one will be simpler and better. (Applause.)

THE CHAIRMAN: Dr. Waldo will you now read your paper on silicon bronze wire?

DR. WALDO: It was merely some remarks in a discussion with Mr. Preece and also in correspondence with Lazare, Weiller & Co. In Paris I became a good deal interested in this silicon-bronze question. I take it that we can look upon all conductors of electricity as merely transparent to electricity, so to speak, and that electricity will travel through them a good deal as light will travel through glass. (Applause.) In our dense ignorance as to the ultimate nature of electricity, of course we can only surmise in regard to this point, but I take it that that is a good practical conception to bear in mind. Now it has been found that very small

quantities of alloys of the earthly metals is introduced into a very good conductor have very much the effect of the introduction of a small amount of iron or any discoloring influence into glass upon the transmission of light, and that has been found particularly true of some of the earthly alloys—arsenic, for instance and phosphorus and silicon. But there is also a peculiar physical change which takes place when silicon or phosphorus is added to the bronzes. What that change is I do not know. But in thinking the matter over, it has seemed to me that the addition of a small amount of silicon and phosphorus must enable the atoms of molten copper to effect a certain nearer relation to each other—that the centers of the atoms, so to speak, are allowed to come a little closer and that the tensile strength is much increased by the addition of these small quantities of the earthy alloys. But whatever the cause may be, it is an experimental fact that the addition of small quantities of phosphorus and silicon and perhaps some other alloys has given us bronzes which have high tensile strength without any greatly lessened conductivity. Now I began a series of experiments on silicon and its application to these bronzes, to see whether we could get conductors which should have mechanical properties of a high order and at the same time have the transparency to electricity which copper has. The first results of these experiments, after two years of work, are beginning to show themselves, and I have here a number of specimens which I shall be very glad to give to any person interested, of some silicon bronze conductors in which a high tensile strength has been

obtained by using a core of silicon bronze and a covering of copper. You are all aware, perhaps, that some of the French engineers have made stretchings of a mile between supports in some parts of Algiers of very hard drawn pure silicon bronze wire. But the trouble with it is that the conductivity is no greater than the conductivity of steel and for most of our purposes we want high conductivity; so I was led into a variation of the ordinary form of conductors and returned to the idea of a cored wire. It was not possible to push the construction of pure silicon bronze conductors up to a tensile stength of 120,000 pounds to the square inch and that rivals the tensile strength of the best steel. But as a conductor for large currents that was comparatively useless and I therefore was led into the experiment of coring the wire. I think by common consent the disadvantages of the old style cored wire arose largely from the difference in electrical conditions between the core and its surroundings. If any moisture got between the steel core and the copper covering we had a perfect electric pile, and a certain amount of disintegration would take place between the core and its surrounding. Now that difference of potential does not exist between the bronze core and the copper covering of a silicon bronze wire, because they are so nearly alike chemically and their electrical condition is almost identical; but there is another very great advantage. The fusing point of silicon—that being an alloy of copper—is slightly lower than the fusing point of copper itself, and it became possible to put in ingots of silicon-bronze and to cast around these ingots pure copper. There would be a perfect joint of fusion so that when the ingots were

taken from the molds there was an ingot of silicon-bronze covered with copper which would have a perfect mechanical homogeneity, and these little samples which have been passed around the room are specimens of wire drawn with a solicon-bronze core with the ends polished, so that you can see there is a difference in constitution of the metal, but it is almost impossible to separate the silicon-bronze core from its outside covering. This is a more or less complete solution of the problem of having electric light conductors of very considerably more tensile strength than anything which copper can give, and yet possessing almost the conductivity of copper. In the case of smaller wires the amount of success reached is equivalent to about the following figures: A wire 103-1000 of an inch in diameter will break at about 650 pounds and for torsion and bending it is much more satisfactory than the best hard drawn copper which we have been able to get. You have, too, variable quantities of conductivity and the tensile strength and you can save either at the expense of the other; so that it becomes possible by using the silicon-bronzes, to vary for particular conditions either of those qualities; and I think the experiments which we have made bid fair to be successful in producing permanently a conductor — not perhaps better than copper because we purify our copper more and more, and the present conductors of copper will undoubtedly be increased—but a conductor which is very good and which will possess mechanical properties which thus far have have not been available.

One thing more as to the ultimate course of experimenting in this direction. The silicon-bronzes made

in Europe have been expensive because of the prohibitory prices put on by the owners of the only patents under which they could be made—the Lazar-Weiller patents; but owing to the genius of the Cowles Brothers in the working of their smelting furnaces by which silicon can be reduced from its quartz in a much less expensive way than any other that has yet been tried, and in consequence of the low price of silicon these silicon-bronzes will be made doubtless at a cost which will not at all be prohibitory for their use in places where wires happen to be swung from supports and tensile strength becomes of great value. (Applause.)

Dr. Moses: Mr. President, the very interesting remarks of Dr. Waldo have elicited from my neighbor here a comment which I would like to bring to the attention of the convention. He suggests that perhaps the hard-drawn core being more slowly acted upon by its own weight in stretching, would perhaps break after the outer covering had yielded. In experiments on the tensile strength they are conducted so rapidly that there is no opportunity that I see for fatigue of metals becoming a factor. It recalls to my mind a remark that was made to me by one of the engineers of the Brooklyn Bridge. He said that he was anxious in the course of a good many years, to find out what the effect would be of the introduction of quite a number of what are called hard wires into the cables of the Brooklyn Suspension Bridge. It appeared that some dishonest contractor had given, strange to say, a better wire than he was called upon to give—that is, a hard wire instead of a soft one; but it had come in the course of manufacture and he had thrown it into the lot of wire

forwarded, and in the tensile strength experiments made it was found to be unsuitable to the bridge, but still he found a means of getting it in. I believe the man is suffering to-day for it in one of the penitentiaries. The conditions were similar to those spoken of by Dr. Waldo, though not exactly the same. The hard wires are supposed to be in that condition, that yielding less than the soft wires, the ultimate strains will be drawn upon by the fatigue of the metal in the course of years, so that those wires are practically speaking, getting the whole strain upon them. I mention that so that in conducting further experiments if you can introduce time into the experiments so as to see the effect of fatigue on the copper covering it will be a very interesting thing.

Dr. Waldo: I think the whole question of the mechanical testings of wire is one of extreme importance. I have been very much struck in testing long series of wires with the disturbance caused by this very fatigue of the metal of which Dr. Moses speaks. In using a testing machine for testing strengths, it is of the utmost importance that the strain be applied very gradually because you could all get different results in a machine where the strain is applied gradually at an interval of several minutes we will say for each wire and where the strain is applied rapidly. I, for one, would like to see a committee or some representative body which should take under consideration the unifying of the mechanical tests for wire for electrical purposes. I think both the bending and the torsion and the breaking tests are all now made very much as a particular whim of the company or person using the

wire prescribes, and if we had a uniform method of making these tests we should have data for preparing conductors mechanically in a way which is not now possible. I do not know but that I am ready to make a suggestion that a committee be appointed having for its province the consideration for report at some future meeting of the convention of the best means of establishing a uniform system for the mechanical testing of wire for electrical purposes.

DR. MOSES: I think Mr. President, that is a very excellent suggestion, and I hope that the President, in appointing that committee, will consider the extent of the investigations of Dr. Waldo by referring the matter to him as one of the members of the committee. There is, I think, a committee appointed for the purpose of considering insulations and wires in general. But this might be made a special subject of investigation, and if it is the pleasure of the convention to appoint such a committee, I hope Dr. Waldo will take charge of it.

THE CHAIRMAN: Gentlemen, I should be very much in favor of appointing such a committee as that. But I was rather in hopes that the appointment would come from Mr. Morrison, as he is perhaps more familiar with the transactions of this Association than I am. But as he is not here, I will appoint Dr. Waldo on that committee and Dr. Moses. Is there another committee already in existence that this could be attached to?

DR. MOSES: It strikes me that the committee of which Prof. Thomson of Philadelphia was in charge had a similar matter in hand.

THE CHAIRMAN: I will add this committee to that committee.

THE SECRETARY: That committee resigned and another committee was to be appointed. That committee was on the proper insulation of wire and the proper installation and construction of plants.

THE CHAIRMAN: We will leave that matter open then until the President appoints the other committee and join this committee with that.

MR. MAILLOUX: In regard to the conductivity of copper, of course it is important to use the specific resistance of the copper, and I would like to ask Dr. Waldo a question particularly directed to finding out whether electrolytically produced copper has ever been used in making wires. I have had considerable experience in making copper by electro-deposition and I found it is possible in that way to make a copper which is not only very pure—sometimes 999 fine, but it is also a very ductile substance and it can be bent a large number of times without showing an absolute rupture, and it seems to draw out in bending, so that the broken ends look very much like an electric light carbon for instance, and it occurred to me that perhaps some attention should be given by wire makers to the use of that kind of copper.

DR. WALDO: I confined our experiments at first to copper which was electrically deposited on the cores, and we obtained some remarkably fine specimens of wire in that way; but the cost of the process was prohibitory and the copper which I have used frequently is merely the highest grade of Lake Superior copper.

MR. MAILLOUX: Referring to electrolytically de-

posided copper, I did not mean that it was deposited on a core by electricity but I referred rather to copper which has been produced in the form of slabs by means of electrical deposition. There is now a firm here in New York that has produced, I understand, some 500 tons of plates of copper per month by means of electrolysis, and I meant particularly copper which can be used in ingots just like any other form except that it is very pure and exceedingly ductile.

DR. WALDO: There is great danger in the melting of copper. One of the most insidious difficulties in the manufacture of high grade conductors is the introduction of a sub-oxide and a protoxide of copper as an impurity, and I am very much afraid of any process which involves the constant melting or re-melting, and I should be afraid that electrolytically deposited copper would lose all it would gain by being electrolytically deposited, in any ordinary process of melting. The protection of that copper during melting has been one of the most serious difficulties that we have had to face.

DR. MOSES: In the refining of copper the solution of protoxide of copper in the copper itself is one of the difficulties in the way of getting a pure copper by ordinary smelting processes, because it seems to disseminate itself so thoroughly in the mass of the copper. Now in electrolytically deposited copper, that is not the case, but there are other objections that Mr. Stanley speaks of, and I wish he would bring them before the convention.

MR. STANLEY: I should like to ask the gentleman if he has ever thought of the self-inducting value of the wire—a compound wire having a bronze core and

copper sheath—it seemed to me there might be a secondary action set up in that core that might be very prejudicial to the use of it in alternating currents.

The Convention then adjourned until the following day at 10 a. m.

THIRD DAY'S PROCEEDINGS.

The convention was called to order on August 11, at 10.25 A.M.

THE PRESIDENT: The special order for this morning is the action on the revised by-laws—Mr. DeCamp.

MR. DECAMP: Mr. Chairman, I beg leave to offer the following as a substitute for the present constitution of this Association. I move that it be taken up *seriatim*.

The motion was carried.

THE PRESIDENT: The Secretary will read the Revised Constitution *seriatim*. If there be no objection to the articles as read they will be passed. I suggest that you pay close attention to it so that it will not be necessary to read it over twice, as before.

The Secretary then proceeded to read the proposed Constitution as follows:

CONSTITUTION.

I.

The name of this Association shall be "The National Electric Light Association."

II.

Members of this Association shall be companies, firms, or persons, operating electric light and power

stations for public or commercial purposes, manufacturers of electrical supplies and apparatus. Electricians, electrical engineers and persons, firms or companies whose profession or business is directly collateral thereto, may become members upon the recommendation of the Executive Committee and approved of by the Association.

III.

The officers of this Association shall be a President, two Vice-Presidents, Treasurer and Secretary, and an Executive Committee of six members, the President, Vice-Presidents, Treasurer and Secretary being members *ex-officiis*.

IV.

The Presidents and Vice-Presidents shall be elected by ballot to serve from the close of the annual meeting at which they are elected until the close of the next annual meeting.

The Treasurer and Secretary, who shall be one and the same person, shall be nominated by the President, subject to the approval of the Executive Committee. The Executive Committee shall be chosen by ballot at each meeting, either annual, semi-annual or special, to hold office from the close of the meeting at which they are elected until the end of the meeting at which their successors are chosen. The same person shall not be eligible to the office of President or Vice-President for two successive terms.

THE PRESIDENT: One moment. I suggest that the first line of the second paragraph be amended so as to read: "The Treasurer and Secretary who *may* be one and the same person."

MR. DECAMP: I accept that.

The Secretary resumed reading as follows:

V.

The duties of the several officers shall be those usually pertaining to their respective offices.

The Treasurer, Secretary and Executive Committee shall make a written report at each meeting to be spread upon the records of the Association.

VI.

The Executive Committee shall be the governing body of the Association, three of which shall constitute a quorum. They shall meet from time to time and shall report upon application for membership, gather and prepare information upon topics of interest and arrange for their discussion at the several meetings of the Association.

VII.

The annual meeting of the Association shall be held in February, and the semi-annual meeting in August of each year at such place as the Association shall determine, and such date as may be determined by the Executive Committee.

VIII.

The membership fee of each member shall be $10— which shall accompany the application.

The annual dues shall be $10— payable in advance and shall cover the calendar year.

IX.

All amendments to the Constitution shall be presented in writing and referred to a committee to be appointed by the Chair before being acted upon by the Association; a two-thirds vote shall be necessary to their adoption.

A ballot may be called for upon the request of five members of the Association.

THE PRESIDENT: What is meant by a two-thirds vote in the first paragrah of Article IX—a two-thirds vote of what?

MR. LEGGETT: At the close of that I notice that a ballot may be called for at the request of five members of the Association; that is, a ballot upon an amendment to the Constitution. I suggest that those words be inserted—"Upon an amendment to the Constitution."

THE PRESIDENT: In the ninth article you say—"a two-thirds vote shall be necessary for their adoption". The way that reads it means two-thirds of the members present.

MR. LEGGETT: It means members present, I presume.

THE PRESIDENT: You better express it—say a two-thirds vote of those present.

A MEMBER: Would it not be well to add "two-thirds of those present and voting."

MR. LEGGETT: I think not, on an amendment to the Constitution.

THE PRESIDENT: The new Constitution is now before you as a whole for your action.

MR. DE LA VERGNE: Would it be in order to make a suggestion at this time? The question comes up there of a person not voting—whether silence is not equivalent to an affirmative vote.

THE PRESIDENT: I should say not.

MR. DE LA VERGNE: I know it is not as a rule. If it be in order to offer amendments I would like to offer some.

Mr. De la Vergne handed some amendments to the Secretary, which were read and laid on the table.

DR. MOSES: May I trouble the Secretary to read that section in which reference is made to the tenure of office of the President and the other officers?

The Secretary read the clause referred to as follows:

"The same person shall not be eligible to the office of President or Vice-President for two successive terms."

DR. MOSES: I would like to enter a protest against that. I do not think that we ought to commit ourselves to a policy which forces us, when we have a good man, to change him for a man whom we do not know. I think that is radically wrong. Leave it open to the judgment of the Convention. A very great philosopher once said: "Promise and danger is near." If we promise to change at the end of a year, I think danger is near. Do not let us bind ourselves in that way to get rid of a man who may be essential to us. I respectfully submit that to the very serious consideration of this meeting.

MR. STEUART: I would only like to add my voice to the excellent suggestion of Dr. Moses on this particular point. I think it would be very unwise to tie ourselves to a one-term government. We know that our Association is growing and we know that it is still in the formative state, and we know how great an influence a good leader has upon an organization in the condition of this one, and therefore I think it would be most unwise to pass this clause in the amendment to our Constitution which would compel us to cut off the steering hand that was guiding this Association to better things, and I would suggest that that clause be stricken out of this Constitution and either omitted

altogether or some other inserted which will leave it, as the Doctor very properly says, in the discretion of the Association to retain a man if they find him valuable and necessary, as he may well be, to the service of the Association. (Applause).

MR. DECAMP: I am prepared to agree with both the gentlemen who have just spoken, and I rise to say a word on the other side of the subject, without any hesitation, as I know that our present chairman is heartily in accord with me on this very point. On the other side of the question is this—the Association now is holding its sixth session; it is young yet and we need a strong man at the helm. But if you read this carefully you will see that it provides that the same person shall not be eligible to the office of President or Vice-President for two *successive* terms. To say that this Association at this period of its existence cannot stand a mistake for one year is not paying a very great compliment to our present presiding officer. I think he has made it strong enough to stand a blunder that we might make for one year. Should we make such a blunder for one year, we could put him back again. If we do not have that privilege I certainly would vote in the direction which Dr. Moses suggests, for striking it out.

MR. PHELPS: I wish to add my word to what has been said by Dr. Moses and Mr. Steuart in respect to the point just now mentioned. It seems to me that it is very important to preserve a continuity of action in institutions like this, particularly in their early days. We know very well that the affairs of the Association have been carefully looked after and steered and

directed by the present officers. The suggestion that we might safely interrupt the present order of things for a year is all very well. Of course we should not go to the dogs in a year. But there would be a *hiatus* and perhaps some slight change of policy in one direction or another which might be to the detriment of the Association and I fail to see any reason whatever why we should fear to leave that matter absolutely to the discretion of the Convention from year to year. The longer a man who is willing to continue in a position continues in it the more valuable he becomes. His work is cumulative and from year to year it goes on and increases in value. We have been fortunate in having officers of that character, particularly the presiding officer and I hope that we shall have the same kind of service and be at liberty to ask for it as long as we choose.

MR. LEGGETT: In the matter of this amendment to the Constitution we considered it very carefully in committee, and it seems that the desire to erase this clause arises from the wish to retain our present President who certainly has served the Association with very great ability. Now the clause itself is proposed from a desire to follow his judgment. He has proved to be a man of very excellent judgment in the management of our affairs. Now, why should we reject his judgment when his judgment points directly to this change in our Constitution? It is the judgment of our presiding officer that this amendment should be made. It seems to be in the interest of harmony in the Association—or not so much harmony, you might say, as *esprit de corps*, to give to every section the opportunity of having his

president. It is an honorable position. It is a position which any one in the Association might well feel honored in holding. It is one of those things which might well be passed about to maintain interest in the Association. We know that our present Chairman is capable and is abundantly able to hold this position.

There are doubtless many others in this Association who are able to fill his place. Now, while in the early life of our Association it is wise to be governed by men who have the interests of our Association at heart, yet if we are going to make a change, that change ought to form the fundamental basis of our Association, so that it may hereafter under no circumstances form a bone of contention. It seems to me a wise method to incorporate this into our Constitution. Now, you may not have observed closely, as we did observe in committee, the relation of this particular amendment to another clause of the Constitution as we have framed it—that is the appointment of the Executive Committee. The Executive Committee, the committee have decided, should be elected at each meeting; that is to say that it should hold office from the end of the meeting at which it is chosen until the end of the next succeeding meeting—not the annual meeting, but the next succeeding meeting whatever it might be—one of the biennial meetings or a special meeting. The object of that was particularly to choose, as an Executive Committee, at least certain members who might reside at or close to the locality where the next succeeding meeting is to be held. We are generally governed in selecting these places by some consideration which points to a particular place for the holding of the next meeting—for instance,

Washington or Chicago. There is some particular section which the Society may have in mind as being particularly available for the next meeting. Now, it seemed to the Committee that it would be wise to appoint an Executive Committee each time so that the new Executive Committee would be localized to a certain extent. Now, with this localizing of the Executive Committee it seems that the rotation of the office of president might well be made without detriment to the society. It would be a little different if we had an executive committee which was all the while constant, as we have had practically up to the present time, because they are the channels of communication and they have become so well fixed that they soon resolve themselves into an easy method of doing business. That will be broken up by this change. It seems to me that it is proper to have that as a part of the fundamental constitution of our society—pass the honors around.

MR. KINSMAN: I understand that the discussion is as to whether we shall be compelled to choose a President yearly or make it optional with the Convention.

THE PRESIDENT: This by-law makes an annual election. The President and Vice-Presidents shall be elected by ballot to serve from the close of the annual meeting at which they are elected until the close of the next annual meeting.

MR. LEGGETT: Of course the Constitution can be changed at any time by a vote of two-thirds. If we find that the rule does not work well it is easy to change our Constitution.

MR. KINSMAN: Wouldn't it be wise to make that optional? We may, with an optional clause, be told it is the one year arrangement, whereas with a compulsory clause we are obliged to follow that without amendment.

MR. WEED: The remarks that have been made by members of the committee seem to me to emphasize a defect in this Constitution to which attention has already been called. I take it no society can do its best work unless there is something like permanence or continuity in its work. That may be attained through a single officer who shall hold office for some years or it may be attained by means of a committee. I believe this morning reference has not been made to one point that came up the day before yesterday—namely, that it was desirable to have the President chosen from the city where the Convention was being held. That, I take it, was one of the points that seemed desirable to the gentlemen who first proposed to make this change. If that argument be considered strond and valid it certainly seems to me that the Executive Committee or some other body should have a considerable degree of permanence. The Executive Committee might include—just as an illustration, I do not mean to say that these would be the best periods—one member who should hold office for say two years, another for a year and another for six months, and then others to be selected from the locality where the meeting is to be held. In this way it would be possible for the Association to avail itself of the services of those who have the interests of the Association at heart, whether they be in the President's office or otherwise, by keeping them on the Executive

Committee for several meetings. At the same time the burden would be somewhat distributed. The traditions of the Association would be distributed among a number of men, all of whom could not regularly meet, because the Association is so widely scattered, and there would also be some representatives of the cities where the conventions are to be held. After some experience in bodies like this it seems to me that it is absolutely essential to provide in the Constitution for a governing body that shall have a moderate degree of permanence. It seems to me that to make the President's office and the Executive Committee changeable every six months destroys almost wholly the idea of permanence. If this Association is simply to meet for good fellowship, the plan before us might work. If it is to do anything in the way of Committee reports and work that shall be continued from year to year so that some definite plan shall be marked out, I should certainly consider it a misfortune if this Constitution should be adopted so as to have the officers so far from permanent. I do not think it healthy to be changing constitutions every moment.

THE PRESIDENT: Just one moment. Let us get this thing in shape before we go along any further. You are all talking at random. Your time is somewhat limited and I suggest that any of the members present who desire to present any matter to the Convention shall do it in writing and discuss it as presented. At present you seem to be going on in a random discussion on the Constitution. None of your suggestions are placed in a tangible form which can be discussed intelligently.

MR. LEGGETT: We did not provide for the entire rotation of the Executive Committee. In respect to the Secretary and Treasurer either one of those officers should be maintained permanently from year to year. As to the Executive Committee, in making changes there you can leave upon the Committee as many of the old members as you see fit. It does not destroy necessarily the permanence of the organisation or the continuity of its business.

DR. MOSES: I listened attentively to the pros and cons in this matter and I find those who consider the interests of the Association profoundly are of opinion that it is well to let the ship go right on in its course without stopping to change screws in mid-oceam simply to get a little larger or little smaller screw. On the other hand the principal arguments seem to be altogether based on the desire of the President whom we now have in office to get out of the responsible position that he is in, at some future time. Now, that is altogether a personal matter. Personal feelings ought not to come into play here. We ought to consider the welfare of the Association, as I look at it, and as all the arguments seem to be on one side and all the good feeling and sentiment on the other I think we ought to let the arguments prevail.

MR. PHELPS: I move that the Constitution be taken up section by section and voted upon.

The motion was carried.

The Secretary read Article I.

THE PRESIDENT: Are there any amendments to this section? If not, a motion to approve is in order.

On motion, Article I was adopted as read.

The Secretary read Article II.

MR. EUSTIS: I would like to ask whether if a concern or company is represented by two or three or more members present, each member present shall have a separate vote or the company have only one vote without regard to the number of its representatives.

THE PRESIDENT: The Company has a vote—one vote.

MR. GARRATT: To meet a possible contingency there, should there not be a provision that gentlemen connected with a business enterprise directly, should not be entitled to individual membership which would entitle them to an individual vote? Suppose four gentlemen connected with one company come into this Association that company is only entitled to one vote. If these gentlemen as individuals—

THE PRESIDENT: Each one is entitled to a vote.

MR. GARRATT: I wish there could be a very close and accurate ruling in regard to the membership of this Association so that companies and corporations shall only be entitled to one vote, actually, as well as in name. I see an element of danger there. I want to call your attention at it.

THE PRESIDENT: I do not see how you can make any legislation to cover that point. You cannot prevent a man who is eligible to membership in the Association from having the right to vote, if he becomes an active member.

MR. GARRATT: There is no legislation then to prevent two or three employees of a company from joining the Association?

THE PRESIDENT: None that I know of. If you are

engaged in practical electric lighting business you are entitled to membership in this Association if you comply with the other rules.

MR. DE LA VERGNE: I suggest that only one authorized representative of a company be allowed to vote on any one question.

MR. DUNCAN: The provision under consideration goes on the idea that each company would have one representative; but they could have as many persons present and attending the Convention as they saw fit. There is also a provision in the Constitution which says that all applications for membership shall be referred to the Executive Committee. It is presumed that the Executive Committee would take cognizance of the fact that an applicant was an employee of a corporation, the idea being that the corporation was entitled to one vote. When you come to vote on a question affecting the interests of local light companies they would only be entitled to one vote and the individual membership could not vote on a question like that. It may not be distinctly set forth in there. We wanted to retain as much of the membership as we could. The general idea is set forth there that all applications shall go to the Executive Committee and they are the power which governs and controls and will look after that feature.

MR. GARRATT: I understand then, you think there is no element of danger there to the democratic spirit of this Association.

MR. DE LA VERGNE: If the Chairman would allow me to make a remark—(the speaker's remark was inaudible to the reporter.)

THE PRESIDENT: Mr. De la Vergne offers an amendment to section 2. Let me say this, that in getting up the membership roll we have never had a question of this sort arise. There has been no interference of that character at all. Now, there is no way by which you can prevent a man actually engaged in electric lighting business and coming here and complying with the rules of this Association from becoming a member of this Association. That is all there is in the case that I can see.

The Secretary read the following amendments to Article II. proposed by Mr. De la Vergne:

No person shall be appointed to, or if appointed serve, on any committee who is pecuniarily interested in or is employed in connection with the production or sale of any article, the use or sale of which is to be directly affected by the examination or report of such committee.

No person, as appointee, in purchase or use of supplies in electrical industry, shall be appointed to, or if appointed, serve on any committee, the duties of which involve the determining of or reporting on the relative value or merits, in use or economy, of any article or commodity entering into consumption in the department represented in the line of duty or duties to the faithful discharge of which he has been appointed, in such industry.

MR. MASON: I move the adoption of that amendment.

MR. GARRATT: I second the motion.

THE PRESIDENT: Do the members see the scope of the amendment? That is, that if a committee is appointed on wire, no man engaged in the wire business can be appointed on that committee.

MR. R. W. POPE: Would it be known to the Committee whether a person was actually engaged in the wire business or interested in wire? A man might be appointed on that plan who is not engaged in the wire business but who may be an inventor of wire. If it is practicable I favor its adoption. If it is impractible I do not see the use of it.

THE PRESIDENT: If that amendment prevails then you will cut off from the service of this Association the men who have the greatest intelligence in any one of these lines. If you want a committee on wire you want wiremen. If you want a committee on steam engines you want steam engine men. You don't want a steam-engine man on a wire committee or a wire-man on a steam-engine committee.

MR. DE LA VERGNE: I made those sections so that they might be acted on jointly or separately. Perhaps if the last one was read it would make them acceptable. The last one is as follows:

No person shall be appointed to, or if appointed, serve on a committee, the duties of which involve the examination into or reporting on the qualities, claims, or adaptability of any article or commodity entering into use in electrical requirements who is not possessed with some familiarity or practical experience in such or like use.

That would make it neceesary that a person appointed on any committee should be familiar with the subject: he simply should not be interested in the results of the examination personally.

THE PRESIDENT: It does not alter the case at all in my judgment. We are about two and a half years old and during that time we have done some very good

work and that work bas been done by using the trained intelligence that exists in this Association. Probably one of the best papers that was ever presented to this Association, upon steam engines, was written by a gentleman who is more keenly alive to his own interest than any other man in the Association, and yet the Association had the full benefit of his experience and training and the peculiar knowledge a man can acquire only by handling a subject practically. I could point out to you from memory numbers of cases where you have got the most useful information from gentlemen who in presenting the particular subject to the Association probably had their own interest in mind first. There are very few angels or unselfish men in the electric lighting business any more than in any other business. What we want here is to get the best information we can obtain. Now, if I present a case and it is a grossly personal one there are many men in this Association who will light right into me and the fur will be flying here in all directions. (Laughter). If a member is appointed on a committee and he impresses that committee too much with his personality you will generally find there will be some one to show him up before he gets through. I shall vote against the amendment.

MR. GARRATT: I am convinced that I am wrong. If it is parliamentary to do so I will withdraw my second to that motion. I am convinced that Mr. Morrison is right and I believe that there is no man here, no matter what his personal interest might be, who would not lay that interest aside in a committee

report; and even if he did not do so there are many men who would yank him up with a round turn.

MR. MASON: If the body will permit it I would like to offer a good example and withdraw my motion.

MR. DE LA VERGNE: I offered this only because I thought that there was a feeling among the members that there ought to be some such provision in our Constitution. Take the case where two gentlemen approach an electrical establishment. One of them offers a perfectly good material, which would be useful, and offers it on its merits. Another offers perhaps the same thing but does not confine it to its merits and is so generously disposed that he wants to show his appreciation of the person with whom he is talking by making him a present and sometimes that article gets the better of the other. I supposed that was the objection on the part of some gentlemen to supply people being members—they might get people to favor their products in that way.

THE PRESIDENT: There has been some objection made here and I decide that the motion to adopt cannot be withdrawn.

MR. MASON: I move, sir, to lay the motion on the table.

MR. GARRATT: Isn't there an original motion before the house?

MR. MASON: There is a motion to adopt this amendment. I move that the amendment lie upon the table.

The motion to lay on the table was seconded.

MR. LEGGETT: I think there is a question before the house. The motion to lay upon the table is the

substitution of a new question. I would ask for a vote right on the amendment itself.

MR. DAVIS: If there is a motion to adopt that amendment for the purpose of facilitating business I will second that motion.

THE PRESIDENT: The question is on the adoption of the amendment.

The amendment was lost.

THE PRESIDENT: The amendment is rejected. Are there any other amendments to Section 2?

MR. STEUART: I move the adoption of the section.

Section was adopted as read.

The Secretary read Section 3.

MR. WEED: I move this substitute for the part relating to the Executive Committee:

The Executive Committee shall consist of three classes of members, viz., the President, Vice-President, Secretary and Treasurer, *ex-officio*; of three members chosen at each meeting from the neighborhood of the locality where the next meeting is to be held and to hold office till the close of said meeting; and of four permanent members, one of whom shall be elected at each semi-annual meeting to hold office for two years. At the first meeting after the adoption of this Constitution four members shall be elected to hold office respectively for six, twelve, eighteen and twenty-four months. A member may hold office on this Committee by election and *ex-officio*.

If we are to secure permanence in this way through the Executive Committee it is not desirable, it seems to me, that a man's voice as a committeeman should be affected by his election as President; especially if this new proposal is adopted in a later section that the President's office shall rotate. In this way I think we

have the means of providing for a good representation in the locality where the meeting is to be held; we have some permanence, and it seems to me that better in this way than in the other ways suggested are the ends sought to be attained.

MR. DUNCAN: In regard to this section, while I have no objection whatever to the length of time, the same object is attained in the report of the Committee, it being taken for granted that the President of this Association will not make any change nor the Association itself radically change the Executive Committee, the idea being to provide in some way a local representation at the meetings to be held in that particular locality, and it is altogether in the hands of the Convention and Chairman to name that Committee so as to obtain the same result, unless we want to go in and form the association so that the Executive Committee would be a long continued one. If you choose to do that this plan is a good one. If you do that you should make your officers as permanent as your Executive Committee. But this same result can be obtained and is obtained in the report of the Committee.

MR. DECAMP: If the gentleman had served on the Executive Committee or Nominating Committee he would know the great difficulty of getting men to serve and be active on those Committees. You remember that the bulk of the work of the Association falls on that Committee. It is necessary to have men who will give their time to it and who are close enough together to meet occasionally, and for this reason I think that while the amendment is good under some circumstances, it

would be impractical in this case. Therefore I would move that the amendment be laid on the table.

The motion to lay on the table was carried.

THE PRESIDENT: The question reverts now to the adoption of the original article as read.

On motion the original article was adopted as read.

Article IV was read by the Secretary.

MR. DE LA VERGNE: I want to offer this as an amendment to the portion of that article which refers to the election of President and Vice-Presidents, to follow immediately after that. After the words "until the close of the next annual meeting," insert "unless by unanimous consent, at least two-thirds of the membership being present."

THE PRESIDENT: I call your attention to the fact that you cannot get two-thirds of the members of this Association present at any meeting.

MR. DE LA VERGNE: Would it answer then to take out "unanimous consent" and let it be "two-thirds of the members present?"

THE PRESIDENT: It would read then "unless two-thirds of the members present vote."

MR. DUNCAN: I would like to call your attention to the fact that "unanimous consent" and "ballot" cannot very well come together.

MR. DE LA VERGNE: What I mean by this is that it is for one year unless by unanimous vote.

MR. STEUART: If I may be permitted I would suggest that the gentleman's amendment is out of order, because he is attempting to introduce it at the wrong time. His amendment has application to section VIII of his Constitution and not to the one now under dis-

cussion. He is striving by his amendment to avoid the clause which provides that the President shall hold office for one year only and his amendment, as I understand it, applies to the fact that he should be elected for one year. Presidents are always elected for one year and are at present open for re-election. This eighth clause provides that they shall not be re-elected. I suggest that the gentleman withdraw his motion until the proper time.

MR. PHELPS: There is no motion, I believe, in respect to this amendment. I move that Article IV as read be adopted.

MR. GARRATT: Is this in regard to this particular clause or the whole article?

THE PRESIDENT: The whole article.

Article IV was then adopted as read.

The Secretary read Articles V, VI, VII and VIII, which on motion were adopted respectively as read.

The Secretary read Article IX.

MR. STEUART: The President calls my attention to one fact which I think is an oversight on the part of the Secretary. The last clause of section IV which was adopted just now which relates to the election of the President and which we were discussing relates to the fact of his being chosen by ballot for one year and has appended to it at the end an additional clause which, if my recollection serves me properly was not read and was not considered in that vote. That was that the President shall hold office for one year only and shall not be eligible for re-election. That clause has not been passed upon by the Association according to my recollection.

THE PRESIDENT: The clause is a part of section IV. It was read by the Secretary and the Convention adopted it.

MR. PHELPS: I do not think I heard it and I was attending very closely.

THE SECRETARY: I read it twice. I read it when we first went through it and I read it for the second time.

MR. PHELPS: I move that we reconsider the vote on section IV.

THE PRESIDENT: I beg you will pay special attention to the business before you. If this is not well done now it will interfere with you materially in the future. This section was voted upon and I had the paper in my hand when the question was being put.

The motion to re-consider was put.

THE PRESIDENT: The Chair is unable to decide from the sound.

A rising vote was called for.

A MEMBER: I suggest that it would be unfair for those who were present when that was passed to have it reconsidered now that they are absent. A great many have gone out, and that matter was duly considered and I think it ought to stand.

MR. STEUART: I suggest that in view of the very decided opinion of a very large number of the members here present that this section was not considered—certain it is that a number of the members of this Association were anxious to consider it and anxious to pass upon it, were watching for it and ready to move when it was read—in view of the very decided opinion of a number of us that it has not been read, with all

deference to the Chair we think it most desirable that it should be taken up and given that consideration which the members think belongs to it. We do not think it should be run through on this sort of a technicality.

A rising vote was taken upon the motion to reconsider. Nineteen voted aye and two no, and the motion was declared carried.

Dr. Moses: I move, if it is in order, that all of that resolution contained in lines 10 and 11 be stricken out. The words are "the same person shall not be eligible for the office of President or Vice-President for two successive terms."

Mr. Steuart: I second that motion. I think the key-note has been touched by the gentleman who spoke upon it just now. This Association, as has been properly said before, is still in a formative condition. The discussions for the last four or five meetings have been upon those things which we were all doing in connection with electric lighting. We have passed through the primary stage of education and we are coming to a point where it is necessary for us to consider the further development of the science and the new work that is being done. That new work requires careful discussion by competent men, and I would suggest just here that one of the best reasons for striking out this clause is that in order that this Association may be useful, in order that it may grow, in order that the Conventions of this Association may be valuable and important to the members, there must be some hand in the Executive Committee that will guide the discussion and map the plan of talk at the coming Convention and direct it into channels which are new. Now, if you will take a man

who is entirely new to the position of President and new to the Executive Committee and put him in the position of President we will not be able, I suggest, to get that kind of advice to the Executive Committee which we so much need. We want a man as President of the Association who will be able carefully to look back upon the line of discussion which has already taken place in previous meetings, and direct the discussion which is to take place in the future into channels which will be useful.

The motion to strike out was carried.

The Article as amended was then read by the Secretary and adopted.

MR. LEGGETT: I suggest to insert after the word "ballot" the words "on such amendment," because we have already provided in section I or section II—I forget which—that one-fourth of the members present might call for a ballot any time.

Article IX thus amended was adopted.

THE PRESIDENT: Is it desired to have this whole Constitution read over again as amended?

A MEMBER: I move that the Constitution be adopted as a whole.

The motion was carried.

MR. GARRATT: It is a well recognized fact, which I think we all admit, that the strength of an Association or body which finds its work in legislative procedure depends upon the familiarity of the individuals with the Constitution and the By-Laws of the Association, and I would move that the Secretary be instructed to have printed copies of this Constitution struck off as soon as convenient and mailed to every name on the official roll

of the Association, so that we may, before we meet again, have this Constitution at our tongue's end. I would further add that the Executive Commitee adopt one of the manuals of Legislative rules, which shall be kept upon the table and to which disputed questions, such as have arisen to-day may be referred without further question. A gentleman near me suggests a thousand copies.

THE PRESIDENT: It has always been the practice of the Secretary to furnish to each member applying for admission a copy of the Constitution together with his bill for twenty dollars.

MR. GARRATT: Will the old members get it?

THE PRESIDENT: You will all get it as soon as printed.

MR. GARRATT: Can there be any action on the manual?

THE PRESIDENT: I would suggest that you have a short digest published in connection with the Constitution. What is your idea, Mr. Mason?

MR. MASON: My idea is, sir, that we better not adopt any manual.

MR. GARRATT: I understood Mr. Mason to say that he believed it would be a good plan to do so.

MR. MASON: You misunderstood me. All the rules we need to govern us it seems to me are generally understood to be those in the general manuals that do not conflict.

MR. GARRATT: You would not then take any one manual—is that your idea?

MR. MASON: That is my idea.

THE PRESIDENT: The parliamentary law governing this Association has been in the gavel heretofore.

MR. GARRATT: A question arose today in respect to a motion to reconsider a vote after certain members who had voted upon it had left the room. That was in direct opposition to all parliamentary rule, but it was allowed to pass.

THE PRESIDENT: There is no parliamentary law that is violated by the putting of that motion to reconsider.

MR. GARRATT: There is a parliamentary law which will prevent reconsidering a matter if any gentlemen have left the floor.

THE PRESIDENT: Not at all. This body is presumed to be in session until a motion to adjourn is carried.

MR. GARRATT: I will not dispute with the chair but I am still of the opinion that what I say is correct.

THE PRESIDENT: The next business in order is the report on wire gauge by Mr. Garratt.

MR. GARRATT: I made all the report I had to make at the first session of this convention. I did not know that I was to be called upon for anything further.

THE PRESIDENT: The convention laid the matter over until to-day and the question was upon the adoption of the report made by the committee on wire gauge.

MR. PHELPS: I have a resolution to present for consideration in respect to the report of the committee in consonance with the ideas I expressed here the other day on the subject:

Resolved, that the report of the committee on wire gauge be received and the committee discharged with

the hearty thanks of the association for the valuable work accomplished by them and presented in their table of the mathematical properties of the metric gauge; and it is further.

Resolved, that in view of the large number of gauges already in existence and the confusion arising in their use, it would in the judgment of the National Electric Light Association be inexpedient to promulgate an additional gauge. The association earnestly recommends to its members and all others using copper wire the practice of designating sizes by definite diameters, such practice having already come into extensive use, as a feasible escape from the confusion of many gauges. The Association further recommends the use of the meter and its fractions in designating diameters, and in furtherance of that end, publishes the tables presented by its wire gauge committee August 9th.

MR. MASON: When I made the motion to make this the order of the day it was in view of a resolution like the following, which I will beg leave to submit as a substitute for the other:

Resolved that the report of the wire gauge committee be accepted; it being understood that by accepting it, we, as an Association, commit ourselves to the following:

First: That in reports, communications, &c., we will designate wires by their diameters expressed in fractions of the meter.

Second: That in our personal conversation and business we will designate wires in the same way in so far as we find it possible.

Third: That this Association offer to wire manufacturers such aid in the way of information as shall

enable them intelligently to list their wires on the metric system.

Now, Mr. President, my point is this: If a man wants a gauge we have a gauge there in the table which has been presented to us. I beg leave to differ a little from the chairman of the committee on that point. The left hand column of figures upon the table which is before the convention contains arbitrary numbers, although they are based upon the second column—the tenth of a millimeter—but we have there a guage and these numbers will undoubtedly, if such resolutions be passed come into use by us. We can telegraph for wires under these numbers. I am very confident that the majority of the Association feel that while we do not wish to go any further than is necessary in this matter, we want to do something that will commend itself to the users of wire and the makers of wire throughout the country. It seems to me that we are only following in the line of action taken by our government, and taking a very modest step if we shall adopt the resolutions just read.

MR. GARRATT: I understand you, Mr. Mason, that that would not, of necessity, oblige us to do anything only in so far as we found it convenient in our business.

MR. MASON: I understood, Mr. President, that a letter was read six months ago in our session from Messrs Brown & Sharpe, in which they stated that they regarded the proposed metric gauge as very superior to their own and if this convention would in some way adopt it or express its approval of it, they would be very glad to adopt it for use in the measurement of their wires. That was a very stroug testimonial to the value

of this proposed system and I would like some action taken which would lead them to do that which they proposed to the association that they would do. Other wire manufacturers will probably follow in the same line, and as a dealer in wires I feel that we shall all be greatly convenienced. I received an order a short time ago for a number of miles of wire from the far West. The order simply read so much No. 8, so much No. 10, and so much No. 12. I sent them the Brown & Sharp gauge. They were to a certain extent useless out there. The gentlemen ordering used the Birmingham gauge. If it is understood that this association has, in a general sort of way, even adopted this metric system, we shall have our orders and know what they mean.

MR. GARRATT: I would vote strenuously against any adoption of any system of wire measuring which should, in a cast-iron way, commit us to it. I would not vote for the adoption of any system of measuring wire which would not leave each individual completely at liberty to do whatever he wished to do. If a man cannot find it more to his advantage to use this system while measuring than any other, we never can oblige him to do so and I would personally decline to commit myself to it. My idea in regard to that would be this: Take such action as would leave us at liberty with the commendation and encouragement of the association to use a better system of measuring than we heretofore have had; the best I know of being the application to the wire of its simplest principle, namely, its diameter, measured in a decimal fraction of the meter.

MR. MAILLOUX: I perhaps permitted myself to say too much in the previous discussion, and I may have

been construed to mean that I disapproved of the work done by your committee. I think it is doing justice to myself and to the committee to say that I am heartily in sympathy with the work. I believe I took especial care to express my appreciation of the precision and care with which the work has been done. I agree perfectly with the sentiments just expressed by Mr. Garratt. I regard the valuable work done by them as a priceless contribution to the fund of knowledge which we have, regarding the methods by which we measure the various properties of wire. At the same time I am aware, as you all are aware that in this country the inch is used very extensively. Since the discussion on Tuesday I have taken the opportunity to speak of the matter with several gentlemen, makers of electrical machinery, who are using wire in very large quantities, and they have told me that so far as they were concerned they could only make use of this gauge to a very limited extent—that it would not apply to their purposes— that they would adhere to the method of determining sizes by thousandths of an inch, because as they use the foot as the unit of length it would be very inconvenient to determine the area of sections of conductors in one system of measurement and the length of them in another system of measurement; so that in making computations as to the space occupied by wire or as to the weight of wire they would find themselves in a worse predicament than they were before. I also noticed that in wires of certain applications the thousandth of an inch is more convenient than the other. Now, I believe that while the system proposed by the committee to be very valuable

and it has undoubtedly a great range of application, I do not think that we ought to force people to accept it, because if one system is more applicable than another the person who finds it of greatest convenience to use that system ought to have the privilege of using it. Consequently, I oppose the motion.

MR. EUSTIS: I would like to speak in regard to that computation of weight which the gentleman was speaking of—changing from millimeters into feet, that is measuring the diameter in millimeters and yet computing the weight for a given length in feet. I think if he had studied the table as much as I have, perhaps he would have found it just as easy to make that calculation or for anybody to make that calculation, from the number which is given as the logarithm of the sectional area and then by simply multiplying that one number by a constant you can get the pounds per thousand feet which is given here. It is immaterial in any computation of this sort, whether you start with an inch or with a millimeter in making the final determination. The constant holds true; because your length, your weight per thousand feet is proportional to the sectional area multiplied by some given constant. Whether you take the sectional area in inches or whether you base it on millimeters it is immaterial. I have here the constant for the calculation of pounds per thousand feet. I will just put that on the board in case anybody would like to have it (illustrating. Log 0.7762516.) That is the constant which is to be subtracted from the logarithm of the area given in square millimeters.

MR. MAILLOUX: It has happened with me several

times that I had to make calculations that very way. I am perfectly aware that it can be done but I was merely referring to the confusion that is likely to arise where you are accustomed to calculate volume by one method. You are quite likely, especially where there are numerous calculations to be made, to forget the constant. I have been obliged recently to make a great deal of use of the metric system in calculation, because I had to design apparatus with reference to plans sent over to me from abroad which were made in the metric system. In a case like that I find it very convenient indeed; but where it is necessary to pass from one to another I have found in several instances that you are likely to be confused by forgetting the constant.

MR. EUSTIS: As the gentleman has spoken about mislaying his constant I would simply ask him how he obtained a constant for the determination of the weight per thousand feet, where the diameter is given in inches. If he has to determine that every time separately, why is it not as easy to determine that in the metric system as in feet and inches?

MR. MAILLOUX: I mean the constant of converting the length of the wire into meters or fractions of it—here Mr. Mailloux's remarks became inaudible to the stenographer.

MR. GARRATT: I simply want to make this request; I have gone to the blackboard in explaining this gauge and my associates have done likewise. I wish opposing gentlemen would not make degmatic statements. Let them step to the blackboard and demonstrate their statements there. It is not fair to rise

against mathematical statements with dogmatical remarks. I have three times called the gentleman to the blackboard to demonstrate against conclusions which I have stated. He has opposed three statements I have made, and three times I have asked him to go to the blackboard and show wherein I am wrong and three times he has declined to go there.

MR. STEUART: I have only one word to say. This opposition to the motion as it now lies before the house, reminds me very much of a bugaboo—it is an imaginary evil that may come and may never come. The question of whether this gauge would be useful is altogether a question of the survival of the fittest. The question which presents itself practically is whether this thing will prove to be so much better that every one will adopt it in preference to inches, and I think that is the only question which is to be determined, and that can only be determined by practical tests in actual use, and I think that the opposition to the passage of this motion, which is merely a suggestion on the part of this association is altogether out of place.

MR. GARRATT: I call for question on Mr. Mason's motion.

THE PRESIDENT: The question now is on the substitute of Mr. Mason's for the motion made by Mr. Phelps.

MR. PHELPS: I have only one word to say, sir. Having prepared the first resolution I naturally have a little preference for that. There is not very much difference between them. What I have undertaken to do there was to emphasize particularly the desirability of sticking to the principle of designating actual

diameters and rather avoid the notion of promulgating a new gauge. The other resolution does not differ very much from it, but there is a slight difference between them which perhaps might be considered.

Mr. Mason's resolution was again read by the Secretary.

MR. WHEELER: That resolution is so strongly worded in regard to this Association committing itself to certain things that I think we want to be very sure before we do commit ourselves, that the gauge proposed is a good one. All the gauges that have grown up from the needs of wire-makers have had the notches made so that the larger sizes differed by larger spaces than the smaller sizes. That is very well shown by the charts prepared by the committee on wire gauges where the numbers are placed so as to correspond with the old gauges, and the first number equals No. 38 of the ordinary gauge and the second number equals No. 32. Therefore the gauges we have been using for the fine wire sizes have six numbers in between the first two of the new proposed gauge, and at about the bottom of the chart, at about No. 00 of the old gauges there are nine numbers of the new gauge which correspond to the one number 00 of the old, which shows that in the fine numbers the new gauge does not have fine enough differences and at the bottom the new gauge has two fine spaces. That is to say, take a No. 38 wire, for instance, which differs from No. 37 by half a thousandth of an inch, and in the new gauge the difference is six times that, which is not fine enough for practical work. We are sure to need some number between No. 1 and No. 2 of the new gauge, and at the bottom we have one

number of the old gauge which covers nine numbers of the new. I think, therefore, that the best thing in view of the fact that we have now 25 or 30 gauges in use is to pick out some one which is the best that we can find and not create a new gauge.

MR. GARRATT: I would say in that connection simply this, that before two conventions I have debated and explained at length the objection raised by the gentleman. He will find it in the electrical papers and in a number of the daily newspapers. I have suggested no gauge. That is simply a table by which to the tenth or the hundredth of a millimeter you can determine the property of any wire you wish. Again, the gentleman says let us pick out a gauge from the existing gauges. Of the present existing gauges there are 14 Birmingham gauges in use to my knowledge and there are 3 or 4 Brown & Sharpe gauges used in America. The question of there being in the small numbers too great variation has been replied to and replied to until I am sick and tired of it. Any mathematician who knows the rule of three can construct from any one of these small numbers the properties, electrical and physical, which he requires. In ordering wire he can order by the hundredth of a millimeter and he can determine that by the micrometer. The statement that those numbers do not correspond to the Brown & Sharpe ratio is entirely impertinent to the question. I repeat that I have advanced no gauge.

THE PRESIDENT: This discussion has gone along far enough and the hour for adjourning the morning session has arrived. Before adjourning, however, it is necessary to dispose of this business. The question

now is, on the adoption of Mr. Mason's substitute for Mr. Phelps' resolution.

Mr. Mason's substitute was lost.

THE PRESIDENT: The question now occurs on Mr. Phelps' resolution.

Mr. Phelps' resolution was carried.

MR. DUNCAN: I desire to enter a motion that the semi-annual meeting adjourn this afternoon at 5 p.m. I make that motion in order that the members may regulate their time for the clambake and such other entertainments as they may want to take in, as also to expedite the business of the convention.

The motion was carried.

THE PRESIDENT: The first paper that will come up at the afternoon session will be that of Mr. Mailloux on the storage battery, followed by Prof. Reckenzaun on electricity as a motive power, and a paper by Mr. Duncan on motors, and that is all that is on the programme at the present time of writing, except to decide the place for the next meeting.

MR. WHEELER: I want to say that Mr. Garratt is dead right about the wire gauge question. I was trying to answer the second resolution; that was all.

MR. DECAMP: I move that the Treasurer be directed to draw upon the funds of the Association for $50, expenses of the attendance of the Secretary at this Convention.

THE PRESIDENT: It is the usual appropriation for the Secretary.

The motion was carried.

MR. DECAMP: I have in my hand a bill for $60 for printing this paper. I move that the bill be paid.

The motion was carried.

On motion of Mr. Steuart the Convention adjourned until 2 P.M.

AFTERNOON SESSION.

The convention was called to order at 2.30 P. M.

MR. LEGGETT: There is a matter which should be of very great importance to many of us—probably to all of us—the undergrounding of wires, which has not been touched upon in the Convention. I would like, if it could be understood that after the reading of the last paper, we might take that subject up for consideration and find out what we can rely on.

THE PRESIDENT: The suggestion is a very sensible one. You have all got to come to it in the end, as I told you two years ago.

MR. LEGGETT: I make a motion to that effect.

The motion was carried.

Mr. Mailloux read the following paper on storage batteries:

THE PRESENT STATUS OF THE STORAGE BATTERY.

In one of his masterly newspaper interviews a well known American electrician once said of the storage battery that it was chiefly remarkable for its power of stimulating the propensity for lying which is inherent in some natures. This sweeping assertion naturally makes me realize very fully the possible risk of compromising my reputation, which I run in undertaking to

make a few observations relative to the storage battery.

Under the circumstances an apology might seem to you to be a suitable preface, but I trust that a simple explanation will suffice to dispel all doubts on your part as to my good faith in the premises. This explanation rests upon the fact that the storage battery, like the dynamo, the arc lamp, the incandescent lamp, and many another thing has grown and progressed. Only a year ago I would have hesitated, perhaps refused, to say anything before you in favor of the storage battery. My reason would not have been a lack of confidence, but rather a feeling that the era of the storage battery was not yet at hand. I felt that this youthful offspring of the great and powerful family of electrical applications promised to play as important an industrial role as any of its colleagues, but I also knew that it had already made one debut some years ago and failed to draw, because it was too young. I would have been sorry to see its chances of success forever spoiled by a second premature attempt. The child seems, however, to have now had sufficient time to mature and perfect its training, and after an interval of some five years it has reappeared upon the scene, this time with a fair and encouraging success. Within a few months there has been in America a great revival of interest in the storage battery, as you are aware. Many of us practical men, who were once disposed to be sceptical, begin to regain confidence. Certainly the applications which have been made of the storage battery in this brief period prove beyond dispute that this time the storage battery is coming to stay. In some cases it found a new and profitable field waiting for it, as for

instance in railroad car-lighting. In many other cases it opened an entirely new range of possibilities by its playing a secondary role. In a word it has a wide sphere of usefulness to cover, through many devious paths, some of which it alone can tread over, and many of which it will compass with the help of other applications of electricity. It does not presume to fill all these parts at once. In the case of some of them it may prove wise to permit the process of evolution to go on for some time to come, before they are considered.

It is not necessary, however, for the storage battery to wait until it can accomplish *everything* before accomplishing *something*. There are many applications where it is now entirely competent to give satisfactory results; and while doing what it is at present capable of, it can learn what it does not know. The dynamo was not at first what it is now, nor was the lamp, nor indeed the details of lighting systems. Electric lighting was limited at first to isolated installations. The range of adaptability, compared with what it now is, was limited greatly. It was necessary to confine the applications of the light to isolated cases of fitness, since the apparatus was too limited in every respect to admit of doing more. But while we were doing what lighting could be done with these facilities,—and making money too, even then,—we were learning to do more. Invention, and the yet greater force evolution, were hard at work to give us better ideas and more practical devices. In time came the central station, such as it was,—and I might emphasize the *such*. Many are here present, doubtless, who were operating these pioneer arc light stations, with long rows of

dummy lamps, to be shifted in or our of circuit for the purpose of balancing the work in the circuit itself. Then came the current regulator, and following in its wake a succession of devices and improvements, of methods, of systems. The evolution of the incandescent light is also of equal interest, and from the useless platinum wire lamp to the very useful alternating system of today, the steps are so numerous and strange that the mind finds itself in a regular museum in attempting to retrace them. I need not tell you that the evolution of the electric light is not complete—the very existence of our organization proves that, since our object is to promote and further the process of development. Each year we have found electric lighting advancing a few steps. Ten years from today we may have made so many of these steps that our present systems may seem obsolete, yet these very systems in their time were good enough to earn dividends with. This is precisely the case of the storage battery. Its application can even now play a brilliant part in electric lighting, but it can be very useful even if intrusted with a more modest part. In a word, it has arrived at that age and condition of development which fit it to enter the active service of civilization and begin the race for promotion. If I may judge by the very favorable attention which the storage battery has received from the public and particularly from those who are dispensing electricity to the public, I think I can venture like our very genial friend and learned colleague, Dr. O. A. Moses, to prophesy that the storage battery is going to be the next greatest step of progress. It has already taken its place in line, and I believe it will speak for itself inside of a year.

With regard to the storage battery itself, it may be said that in following its development since the days of Plante, one meets with an already large and interesting collection of ideas and devices. It is outside of the scope of the present paper to enter into the study of the steps by which the art has arrived at the present stage. The number of patents relating to storage batteries in this country and in Europe is already quite large, nevertheless the number of good storage batteries is exceedingly small. In this respect his toy repeats itself. The large and constantly increasing number of patents on dynamos, lamps, regulators, converters and what not, when contrasted with the small number of those inventions which are really useful, suggests that a large proportion of inventors must have been engaged too deeply in taking out patents, and pay altogether too little attention to the work of reducing their inventions to practice. Passing by the history of the secondary battery and the theories of its action, which properly have no place in a paper like this, it might be of interest to dwell briefly on the objections urged against the storage battery. The two chief objections are, limited life or durability and low economy. I shall frankly admit at the start that in many cases these objections are sufficiently valid to throw the storage battery out of competition. The final commercial test of the storage battery, however, is the prospect of gain which it offers, under the circumstances of any given case. Viewed in this light the above objections to the storage battery lose some of their force. I can cite as an example the case of a Philadelphia hotel which it is proposed to light by electricity. A practical electric light man who

has been engaged in the business of establishing and operating central station plants ever since the beginning of electric lighting, went over the case very carefully and came to the conclusion that the storage battery would be preferable. So well satisfied is he of the fitness of the storage battery that he submitted detailed propositions for furnishing light. The present cost of lighting the hotel by gas is $7500 per annum. For the sum of $6500 per annum, this practical man is willing to assume the responsibility of furnishing light for a term of years. Being a careful and shrewd business man he has made a wide allowance in his calculation. He does not count upon the two years guaranteed life of the battery plates, but assumes a necessity for their entire renewal in one year. He calculates nevertheless to make 15 per cent. on his investment, and I may say that he seldom makes mistakes in his ventures. In this case, the fact that light must be on "tap" for every moment of the 24 hours, becomes an important consideration, and the evident advantages of the storage battery outweigh the questions of durability and economy. Now, taking up the question of durability by itself, I may say that it is greatly dependent, not only upon the kind of battery, but even upon the use to which it is put.

Then perhaps he may neglect to put in more than the quantity necessary for a normal capacity. The result is that the battery is not fully charged, and to furnish the usual capacity it must be discharged by drawing upon its residual charge. He soon finds his battery giving symptoms of disease, and in a short time both the

positive and negative plates will require doctoring, instead of one kind only.

It must be said, however, that improper care is not solely responsible for all the trouble that affect the life of the storage battery. Some difficulties like the scaling off of the active matter, the buckling and stretching of plates, are largely inherent in the battery. They are natural consequences of the manner or method of making the battery. So it may be said that here the storage battery has a personal equation depending on the make, the care, skill and knowledge of the maker. This amounts to saying that some kinds of storage battery are more troublesome to keep in order than others.

The life of a storage battery plate must not be regarded as doomed to remain compassed within the term of a couple or three years. The limit is gradually being extended, and it may be said that each succeeding batch of the product of the factory is slightly better than the preceding. The same may be said of the cost, which of course is an important consideration, in view of the necessity for repairs or perhaps for renewals at certain intervals. The cost of manufacture has been reduced thirty per cent. inside of one year, and it is even expected that it will be brought down to 50 per cent. before the year is up. The prices have not been reduced because the demand is great even as it is. This of itself shows that the storage battery has already a good field of usefulness where it can command to a great extent its own price.

The weight of the battery is another of the objections to be met, particularly for street cars, etc. This objection is one which is of particular rather than of

[illegible] depends on the battery. We [illegible] with 25 lbs. of active [illegible] possible to provide a supply of energy for 6 [illegible] of 100 watts hours per lb. of matter. [illegible] will no doubt be improved upon greatly.

Last but not least among the objections used against the storage battery is that of reduced economy. My esteemed friend and colleague Mr. Andrew Reckenzaun, whom you will have the honor of hearing after me, will give you very clear and precise information on this question of economy, more practically as regards the use of storage batteries for power. I will leave this portion of the subject to him because I know he is a most competent authority. I will permit myself also to recommend to your intelligent work in Europe during the last five years in the application of accumulators to electrical traction and propulsion.

The question of economy considered in relation to the storage battery does not present such difficulties as might at first be supposed. Considered as an apparatus for transforming energy for electric lighting by incandescence, the storage battery has an efficiency so much *below* that of the dynamo, or the transformer, that it *cannot hope* to enter into direct competition with these *in many cases*. Of the electrical energy produced by the *charging* dynamo, probably not more than from 65 *to 70 per cent.* finds its way into the lamps. With *direct lighting*, as we know, we may obtain as much as *90 per cent.* But just here there is a question of great *interest* and importance which arises, namely: the proportion of energy appearing in the lamp as light. In an incandescent lamp probably not five per cent. of the

energy expended is utilized as light. This five per cent. of rays represents the proportion of heat rays which are visible. The other rays are invisible. Now it is also well known that this very proportion of the useful light-giving heat increases with the absolute temperature of the filament. This means that the higher we raise the incandescence of the filament, the more light it gives for a given amount of electrical energy. But when the filament is brought to an excessive temperature its life is not so great. Just here I will note the fact stated by authorities that alternating currents have been found to increase the life of the filament as compared with continuous current. Now I can supplement this with the statement that the storage battery current gives yet much longer life to the lamp. It permits the raising of the filament to a higher degree of temperature, and consequently it leads to a gain in the energy required.

We have found in practice that we can obtain the same average life of 600 hours with a lamp of 2 1-2 watts per candle power, while direct currents would require lamps of 3 1-2 to 4 watts per c. p. In our early work, realizing the great disadvantage at which we are placed, we resorted to the use of lamps of higher economy, so called. The makers of these lamps refused absolutely to give any kind of life guarantee. They were themselves yet more surprised than we, to learn of the remarkably long endurance of these lamps, even on board cars, where the filament is subjected to the wearing effect of mechanical vibration.

Of course I cannot pretend to say what is the cause of this increased life of lamps with the storage battery

current. It is probably related in some manner to the fact that the current of a storage battery is continuous in the strict sense of the term, while the current of dynamos and transformers are wavy in character.

It would seem, therefore, that so far as electric lighting by incandescence is concerned, while the storage battery is opened to the objection of wasting at the spigot, it can claim some saving at the bung-hole, which quite nearly equalizes the difference between the results obtained by the direct and the storage method. Taking our 65 per cent. of energy, or in round numbers 485 watts, we can obtain twelve lights per electrical horse power of 746 watts produced in the dynamo, using lamps of 51 watts, which is the most economical lamp yet heard of, with a continuous current, we have the following results: Out of 746 watts, taking 90 per cent. as available at the lamps, which is a liberal proportion, we have 671 watts or less than 12 lamps of 51 watts. If we consider the fact that, in practice, lamps of 60 to 70 watts per 16 candle power are the rule, the difference would be yet greater in favor of the storage battery. Taking another view of the question we can calculate what is the lowest per cent. of efficiency permissible in the storage battery.

All applications involving the transportation of the cells, such as electrical car traction and railroad car lighting, necessarily shorten the life of the battery. In these cases, the cells are subjected to hard usage both mechanically, from the shaking and jostling, and electrically from the severe rates of current discharge to which they are constanly subjected. Nevertheless, even here the life of the cells is quite remarkable. I

might mention that a certain lot of 153 cells Julien type B were used for six months in street car work, where the current discharge was often raised to 80 or 90 amperes, whereas the nominal rate was only 35 amperes. These cells were afterward put in use on cars of the Boston & Albany R.R, where they have been for some five additional months without being apparently much the worse for wear. It is probable that they will yet give good service for several months before they require attention. When stationary there is no doubt of their ability to last at least two years. At the end of this time, the positive plates will probably need some attention. If the battery has been used properly, and not abused, the negative plates will yet be in as good a state as ever. In fact there is scarcely any limit to their endurance when properly used. One of the chief difficulties with regard to the care of the storage battery, is the tendency of the customer to overdraw on the reserve charge of the battery. The constitution of the battery is such that like many others it is most prone to disease when it is most "run down." Consequently it should never be depleted or allowed to become faint from exhaustion. Keep it well fed and it will thrive. Keep it hungry and it will soon die of inanition. The battery should always be left with a certain percentage of residual charge, somewhere around 20 per cent. It is like a water tank which requires a little water in it all the time to keep it water-tight and in good condition. This reserve is not necessarily wasted. It only means that the battery should be worked at a lower capacity than it has in reality. The customer, however, is liable to overlook

this important point, and when he finds that there is more electricity in the tank than he thought there was he tries to save energy by taking more out of it.

Taking 11 lamps as the result of the direct application from the dynamo, we find that the storage battery must, at 40 watts per lamp, supply 440 watt hours out of each 746 watt hours given to it, or somewhat less than 59 per cent.

I need not dwell at length upon the uses of the storage battery and the services which it can render in connection with electric light plants, for these are quite generally understood, and new ones suggest themselves all the time. The present rate of demand shows that the uses are at least equal to the rate of supply and sometimes in excess. One application of special interest in this connection, however, is that in connection with incandescent lighting, both from isolated and central station plants, the incandescent light is growing in favor so rapidly that where it is already in use for a certain number of hours during the evening, there is an objection to the use of gas at other times. In small installations it would evidently not pay to run constantly for a few lights. The storage battery would here be very useful, if not indispensable, and a number of local companies who could sell electricity for power in limited amount are also turning to the storage battery, since they are compelled to run during the day to supply electricity for a few lamps and motors, they find it would be as well to run to full capacity, using the balance of power to charge storage batteries from which the energy can be drawn later in the evening, to supply incandescent lamps.

In conclusion I hope I have succeeded in making a fair presentation of the storage battery case, so far as it concerns the uses and purposes of electric light men. As I have intimated, the storage battery is as far from being perfect as were the first dynamos with which some of the enterprising men of this very body first paved the way to the great industry that now interests so many minds and enlists so much capital. But it is so far perfect, however, that it is ready to help enlarge this great industry to push further ahead in its wonderful development.

MR. MARTIN: Mr. Reckenzaun's paper, as I understand, also includes the use of the storage battery, more particularly with regard to its application in street railway service. As he touches upon many points, I presume, that have already arisen in Mr. Mailloux's paper, I would like to offer a motion that Mr. Reckenzaun's paper be now read, and then that the two papers be discussed together.

THE PRESIDENT: I presume there will be no objection to that.

Prof. Reckenzaun then read the following paper:

ON STORAGE BATTERIES FOR ELECTRIC LOCOMOTION.

The idea of employing secondary batteries for propelling vehicles is almost contemporaneous with the discovery of this method of storing energy. To Mr. Plante, more than to any other investigator much of our knowledge in this branch of Electrical Science is due, he was the first to take advantage of the action of

secondary currents in voltaic batteries. Plante is a scientist of the first grade, and he is a wonderfully exact experimenter. He examined the whole question of polarization of electrodes, using all kinds of metal as electrodes and many different liquids as electrolytes, and during his endless researches he found that the greatest useful effect was produced when diluted sulphuric acid was electrolyzed between electrodes of metallic lead.

A set of Plante original cells was exhibited for the first time in March, 1860, before the Paris Academy of Sciences; scientists admired and praised it, but the general public knew nothing of this great discovery, thus brought to notice. Indeed, at that period little commercial value could be attached to such apparatus, since the accumulator had to be charged by means of primary batteries, and it was then well-known that electrical energy, when produced by chemical means in voltaic cells was far too expensive for any purpose outside the physical laboratory or the telegraph office.

It was twenty years after this exhibition at the Academy of Sciences iu Paris, that public attention was drawn to the importance of storage batteries, and that Mr. Faure conceived the idea of constructing plates consisting of lead and oxides of lead. At that time the advantages accruing through a system of Electrical Storage could be fully appreciated since electrical energy was already being produced by mechanical means through the medium of dynamo electric machines.

It was the dynamo machine which created the demand for the storage battery, and the latter was introduced anew to the public at large and to the capitalist with

great pomp and enthusiasm. One of Faure's accumulators was sent to Sir William Thomson, and this eminent scientist in the course of experiments ascertained that a single cell, weighing 165 lbs. can store two million foot-pound of energy, or one horse-power for one hour, and that the loss of energy in charging did not exceed 15 per cent. These results appeared highly encouraging; there we had a method of storing that could give out the greater part of the energy put in. The immense development which the electric transmission of energy was, even at that early day, expected to undergo, pointed to the fact that a convenient method of receiving large quantities of transmitted energy, and of holding it in readiness until wanted, must be of the highest importance. Numerous applications of the Faure battery were at once suggested, and the public jumped to the conclusion that a thing for which so many uses could be instantly found must necessarily be a profitable investment, and plenty of money was provided forthwith, not with the idea of commencing careful experiments, and developing the then crude invention, which would have been the correct thing, but for manufacturing tons of accumulators in their first and immature form.

I need not describe the disappointments which followed the first unfulfilled hopes, nor repeat the criticism that was heaped upon the heads of the early promotors. Those early hopes were untimely and unreasonable. A thousand difficulties had to be overcome,—scientific difficulties and manufacturing difficulties. This invention, like most others, had to go through steady historical developments and evolution,

and follow the recognised laws of nature which are against abnormal and instantaneous maturity. The period of maturity has also been retarded by injudicious treatment, but the ultimate success was inevitable. Great advances have been made within the last few years, and I propose now to offer a few facts and figures relating to the present state of the subject with reference to the application of storage batteries to locomotive purposes. It is not within the province of this paper to discuss all the different inventions of secondary batteries nor to offer any suggestions with regard to priority, therefore I will confine myself to general statements. I am aware of the good work that was done in the United States by Kirchoff, 26 years ago, and of the more recent work of Mr. Brush of Cleveland, Mr. Julien and others, but I am more particularly acquainted with the recent achievements of the New York Accumulator Company who own the rights of the Electrical Power Storage Company, of London. I have used the batteries of the latter Company for propelling Electric boats and Electric tram-cars. The first of the boats was the "Electricity" which was launched in September, 1882, and which attained a speed of seven miles an hour for six consecutive hours. Since then a dozen electric boats of various sizes have been fitted up and worked successfully by means of storage batteries and motors of my design. The most important of these were the launch "Volta," and another similar craft, which is used by the Italian Government for torpedo work in the harbor of Spezzia. In the measured mile trial trips the Italian launch gave an average speed of 8.43 miles an hour with and

against the tide. The hull of this vessel was built by Messrs. Yarrow & Co., and the motors were manufactured by Messrs. Stephens, Smith & Co., of London. The "Volta," which was entirely fitted by the latter firm, is 37 feet long and 7 feet beam, she draws 2'6" of water when carrying 40 persons, for whom there is ample sitting accommodation. There are 64 cells in this boat, these are placed as ballast under the floor, and actuate a pair of motors and a screw, coupled direct to the armature shaft running at 700 revolutions a minute. We crossed the English channel with this boat in September last year, leaving Dover at 10.40 in the morning, arrived at Calais at 2.30 P.M., stayed about an hour in the French harbor for luncheon and floated into Dover docks the same evening, at 6.30 with full speed; the actual distance traversed without entirely discharging the cells was 54 miles; the current remained constant at 28 amperes until 5 P.M., and it only dropped to 25 ampires at the completion of the double voyage between England and France. Several electric launches are now being constructed in London, and one in New York by the Electric Accumulator Company.

M. Trouve exhibited a small boat and a tricyle, both worked by Plante accumulators, at Paris, in 1881.

The first locomotive actuated by storage batteries was used at a bleaching works in France in 1882. During the same year I designed an electric street car for the Storage Company, and this was tried on the lines of the West Metropolitan Tramways in March, 1883. It had accommodation for 46 passengers. This car had many defects, and I reconstructed it entirely, and ran it afterwards in its improved form on the South

London Tramways, and also on a private track at Millwall, where it is now in good condition, and I have a similar car in Berlin. M. Philippart exhibited a car in Paris and M. Julien made successful experiments in Brussels, Antwerp and Hamburg. Mr. Elieson is running storage battery locomotives in London. Mr. Julien has also been experimenting with a car in New York, and I believe one is in course of construction for a line in the city of Boston. Messrs. W. Wharton, Jr. & Co. have a storage battery car running at Philadelphia on Spruce and Pine streets, and this energetic firm is now fitting up another car with two trucks, each carrying an independent motor, similar to my European cars.

I have mentioned all these facts in order to show that there is a considerable amount of activity displayed in the matter of storage batteries for street cars, and that continued and substantial progress is being made in each successive case. The prejudices against the application of secondary batteries are being rapidly dispelled, and there are indications everywhere that this method of propulsion will soon take a recognized place among the great transit facilities in the United States. I feel convinced that this country will also in this respect be far ahead of Europe before another year has passed over our heads.

There are several popular, and I may say, serious objections to the employment of storage batteries for propelling street cars; these objections I will now enumerate and endeavor to show how far they are true, and in what measure they interfere with the economical side of the question.

First objection: The loss of energy, which amounts

in practice to 20, and sometimes 30 per cent. Now, every method of storing or transmitting energy involves some waste, but in saying this we need not condemn the system, for after all the term efficiency is only a relative one. For instance a 10-horse power steam engine consumes three times as much fuel per horse power hour as a 1000-horse power engine does, yet this small engine must be, and is regarded as one of the most economical labor saving appliances known to us. Considered as a heat engine the efficiency of the most economical steam motor is but 10 per cent.—90 per cent. of the available units of heat contained in coal being lost during its transformation into mechanical energy. Thus if we find that the storage battery does not return more than 70 per cent. of the work expended in charging it, we ought not condemn it on that account until we have ascertained whether this low efficiency renders the system unfit for any or all commercial purposes. It is needless to go into figures in order to show that, when compared with animal power, this objection drops into insignificance.

The second, more formidable objection, relates to the weight of storage batteries—and this involves two disadvantages, viz.—waste of power in propelling the accumulator along with the car, and increased pressure upon the street rails, which are only fitted to carry a maximum of 5 tons distributed over 4 points, so that each wheel of an ordinary car produces a pressure 1 1-4 tons upon a point of the rail immediately under it.

The last mentioned objection is easily overcome by distributing the weight of the car with its electrical apparatus over 8 wheels or 2 small trucks, whereby the

pressure per unit of section on the rails is reduced to a minimum. With regard to the weight of the storage batteries, relatively to the amount of energy the same are capable of holding and transmitting, I beg to offer a few practical figures. Theoretically, the energy manifested in the separation of one pound of lead from its oxide, is equivalent to 360,000 foot pounds, but these chemical equivalents, though interesting in themselves, give us no tangible idea of the actual capacity of a battery.

Repeated experiments have shown me that the capacity of a secondary battery cell varies with the rate at which it is charged and discharged. For instance, a cell such as we use on street cars gave a useful capacity of 137.3 ampere hours when discharged at the average rate of 45.76 amperes, and this same cell yielded 156.38 ampere hours when worked at the rate of 22.34 amperes. At the commencement of the discharge the e. m. f. of the battery was 2.1 volts and this was allowed to drop to 1.87 volts when the experiment was concluded. The entire active material contained in the plates of one cell weighted 11.5 lbs, therefore the energy given off per pound of active substance at the above high rate of discharge was 62225 foot pounds, and when discharging at the lower rate of 22.34 amperes the available useful energy was 72313 foot pounds, or nearly 2.2 electrical horse-power per pound of active matter. But this active substance has to be supported, and the strength or weight of the support has to be made sufficiently great to give the plate a definite strength and durability. The support of the plates inclusive of the terminals above referred

to weighs more than the active material which consists of peroxide of lead and spongy lead so that the plates of one cell weigh actually 26.5 lbs. Add to this the weight of the receptacle and acid, and you get a total of about 41 lbs. per cell when in working order. Seventy of these cells will propel an ordinary street car for four hours and a half whilst consuming the stored energy at the rate of 30 amperes, or over 5.6 electrical horse-power. The whole set of 70 cells weighs 2870 lbs, which is barely one-fifth of the entire weight of the car when it carries 40 adult passengers, therefore the energy wasted in propelling the accumulator along with a car does not amount to more than 20 per cent. of the total power, and this we can easily afford to lose so long as animal power is our only competition. From numerous and exhaustive tests with accumulator cars in this country and abroad I have come to the conclusion that the motive power for hauling a full-sized street car for 15 hours a day does not exceed $1.75, and this includes fuel, water, oil, attendance and repairs to engine, boiler and dynamo. We have thus an immense margin left between the cost of electric traction and horse traction, and the last objection, that relating to the depreciation of the battery plates can be most liberally met, and yet leave ample profits over the old method of propulsion by means of animals.

The advantages of a storage battery street cars for city traffic are self-evident, so that I need not trouble you with further details in this respect, but I would beg those who take an interest in the progress of electric locomotion to give this subject all the consideration it deserves, and I would assure them that

the system which I have advocated in this brief but every incomplete sketch is worthy of an extended trial, and ready for the purposes set forth. There is no reason why those connected with electric lighting interests in the various cities and towns should not give the matter their special attention, as they are the best informed on electrical engineering and already have a local control of the supply of current needed for charging.

Prof. Reckenzaun then added the following remark:

Gentlemen, I hope you will do me the honor to discuss this subject as thoroughly as our time will permit, and raise as many difficulties and objections as you possibly can, and I shall do the best in my power to answer them. (Applause.)

Dr. Moses: There is one of the maxims of this Association, unwritten and not in the constitution we adopted to-day, that I think we all have in mind at all times—it is, honor to whom honor is due. Mr. Reckenzaun, with a facility that is most amazing to me, in a foreign tongue, has written a very able paper which no doubt will be placed on the files of the Association. There is one sentence in the beginning of his paper which I would have him kindly correct before spreading it upon the minutes, which is owing, as I say, to his not being to the manner born and which will leave an impression that we should not have go forth. He says Mr. Plante turned to profit certain inventions, meaning simply, took advantage of certain natural effects, or used them—that I think to be his meaning. Mr. Plante, though, has never turned to profit a single one of that brilliant series of inventions connected with

the secondary battery which have immortalized his name and which caused him to receive a grand medal of honor from the French Government.

PROF. RECKENZAUN: I meant scientific profit, Doctor. Allow me to repeat that sentence. I say here: "He was the first to turn to profit the action of secondary currents."

DR. MOSES: Would you amend that and say, take advantage of, or use.

PROF. RECKENZAUN: I would be very pleased to.

DR. MOSES: Now for the shaking up Mr. Reckenzaun asks for. I understand that electric boat of his went so smoothly across the channel. I wish I was there. Quite recently I crossed the channel and it took me the same time to cross, four hours, but it was not at all smooth, so that I am longing for the day when we shall be able to go smoothly across. I got a pretty good shaking up then.

There is a question I would like to ask him which is important in its bearing on the running of street cars. Will he give us the weight in pounds of the car that he speaks of in Philadelphia and which he wants us to go and ride upon. We do not want too many of us to go and for that reason I am anxious to know what the strength of the car is, so that we wont break it down.

MR. RECKENZAUN: I have given the weight of the batteries in this paper. In the car which we use in Philadelphia, there are actually 80 cells, because there are considerable gradients to go over. Each cell weighs 40 pounds and the average horse power each is six. Sometimes we only use two horse power and sometimes, going up grades of 5 per cent, we use as much

as 12 horse power, but the average rate is 6 electrical horse power. With reference to the weight of passengers on the cars, we have never carried more than 50 passengers on that car, because it is impossible to put more than 50 men into it. There are seats for 24 and the rest have to stand on the platform or in the aisle.

Dr. Moses: Another question, if you please. What time does it take you to change your battery?

Mr. Reckenzaun: The changing of the batteries takes three minutes with proper appliances. One set of cells is drawn out by means of a small winch and a freshly charged set is put in. It takes the same time to charge the battery as it does to discharge it in the working of the cars, so one reserve set would be sufficient to keep the car continually moving.

Dr. Moses: What is the loss of energy per diem by allowing the batteries to remain unused?

Mr. Reckenzaun: The loss of energy from standing about is probably nothing. If a battery were to stand charged for three months in a dry case the loss of energy might be in three months 10 per cent. I purposely had a set of cells standing for two years charged and never used them. After two years there was still a small amount of energy left. So as regards the loss of energy in a battery standing idle, it is practically nothing, because no one would think of charging a battery and letting it stand for three months or a year.

Dr. Moses: That result is exceedingly interesting, because it suggests something that was done by Faraday in determining the length of time that would elapse before a vacuum would be absolutely destroyed. It was there determined that it would take about one year

for a Torricellian vacuum to disappear; so we have this action really verifying that. It is possible to keep it charged in that way for two years, you say, and still allow of some residual charge.

MR. RECKENZAUN: There was a small amount of energy left. There was still electrical energy left after two years. I have had them stand three or four months and I could hardly appreciate the loss going on, providing always that the cells are standing on a dry floor. If the exterior of the box be moist, or if it stands on a moist floor, there will naturally be a surface leakage going on; but where there is no surface leakage the mere local action between the oxides and metallic lead will not discharge the battery for a very considerable time.

MR. POWERS: There is one important matter, the amount of power used. When it requires from 4 to 12 horsepower to accomplish the work, I would like to know where the loss occurs. If the energy of the street car horse is good for 2 to 6 horse-power, I think I shall have a great deal more respect for the horse than I have had before.

MR. RECKENZAUN: I have made experiments in London with a loaded car pulled by two horses. I put a dynamometer between the attachment of the horse and the car, so as to ascertain exactly the amount of pull, measured in pounds multiplied by the distance traversed in a minute. You will be surprised to know that two horses, when doing their easiest work, drawing a loaded car on a perfectly level road, exert from two to three horse-power. I have mentioned a car in Philadelphia where we use between two and twelve

horse-power. A horse is capable of exerting eight horse-power for a few minutes, and when a car is being driven up grades, such as I see in Boston, for instance, pulling a load of passengers up these grades, the horses must be exerting from 12 to 16 horse-power, mechanical horse-power. That is the reason that street car horses cannot run more than three or four hours out of the 24. If they were to run longer they would be dead in a few weeks. If they run two hours a day they will last three or four years.

MR. PHELPS: Are you prepared to give an estimate, approximately, as to the life of the cells? How long would it be before they would have to be entirely renewed?

MR. RECKENZAUN: The life of the cells must be expressed upon the principle of ampere hours or the amount of energy given off by them. Street car service requires that the cells work their hardest for fifteen or sixteen hours a day. The life of the cells has to be divided; first into the life of the box which contains the plates. This box, if appropriately constructed of the best materials, will last many years, because there is no actual wear on it. The life of the negative plates will be very considerable, because no chemical action is going on in the negative plate. The negative plate consists almost entirely of spongy lead, and the hydrogen is mechanically occluded in that spongy lead. Therefore the depreciation of the battery is almost entirely due to the oxidation of the positive plates. If we were to make a lead battery of plates 1-4 inch thick, it would last many years; but for street car work that would be far too heavy. Therefore we make the positive

plates a little more than ene-eighth of an inch thick. I find that the plates get sufficiently brittle to almost fall to pieces after the car has run fifteen hours a day for six months. The plates then have to be renewed. But this renewal does not mean the throwing away of the plates. The weight is the same as before, because no consumption of material takes place. We take out peroxide of lead instead of red lead. That peroxide, if converted, produces 70 per cent. of metallic lead, so that there is a loss of 30 per cent. in value. Then comes the question of the manufacture of these positive plates, which, I believe, at the present day are rather expensive. But I believe the time will come when battery plates will be manufactured like shoe nails, and the process of renewing the positive plates will be a very cheap one.

MR. MARTIN: How much is the expense for each car mile including depreciation?

MR. RECKENZAUN: I ascertained in Europe that the motive power costs 2 cents per car mile; that is, the steampower and attendance for charging the batteries. We have to allow twice as much for the depreciation of a battery at the present high rate at which we have to pay for the battery, $12 for each cell. But, I believe, that as soon as the storage battery industry is sufficiently extended, the total cost for propelling these cars will not be more than six cents a mile, or about one-half the cost of the cheapest horse traction.

MR. MARTIN: I have listened to Mr. Reckenzaun's paper with a great deal of interest and attention, and was very glad to have the opportunity of gathering so much information in so short a time and presented so

compactly, Mr. Reckensaun has had a priviledge which very few of us can enjoy, and that is of visiting every one of the electric railways in Europe now in operation. His very valuable observations on that subject were recently presented to the London Society of Arts, and presented in so able, masterly and exhaustive a manner as to obtain for Mr. Reckenzaun the silver medal of that society. (Applause.) I read Mr. Reckenzaun's paper brought before that society with a great deal of interest, but there was one point which impressed me very much, and that was that in Europe the merits, the claims and the advantages of the cable system did not seem to enter into the consideration of the case at all. Here we have to deal with that problem. The cable is running in this country; it is running in most of our large cities where the storage battery must find its chief scope and play, and unless with the storage battery we can make a better presentation than the cable men make with the cable and the grip, it is not likely that we shall see the storage battery assume the position and importance which we believe it is entitled to. I have seen various statistics on the subject of the amount of power required for operating a cable railway, and I have seen some of the statements go as high as a loss or waste of 80 per cent. I would like to ask Mr. Reckenzaun whether, since his arrival in this country, he has looked into that subject at all and whether he finds that the loss in getting the current into the storage battery and then delivering it to the motor is less in comparison than that in the use of the cable in the power finally delivered to the car.

MR. RECRENZAUN: I have made some very careful observations on the cable tramway in Philadelphia,

which is quite an extensive system. I have never been able to ascertain the exact amount of waste in pulling the cable itself; but I have it on the authority of certain technical papers that there is a waste of about eighty per cent. I do not intend to depreciate cable or any other tramways, but there is a difficulty about introducing cable tramways. It is necessary to dig up the streets and interfere with the roadways. I have been told that the cable arrangements in Philadelphia cost $100,000 a mile, and that the cable road in San Francisco cost more than that. One of the directors of the cable company in Philadelphia told me that if he had seen the battery system before the introduction of the cable he would probably have made up his mind in favor of the former. The wear and tear in the case of the storage system is also considerable. There is a waste of energy in the dynamo; secondly, in the accumulator charged by that dynamo; thirdly, in the motor which is driven by the accumulator, and fourthly, in the gearing which reduces the speed of the motor to the speed required by the car axles. It would be difficult to make a motor run at the rate of eighty rovolutions per minute, which is the number of revolutions of the street car axle when running at the rate of ten miles an hour. Take all these wastes and you find in practice that you do not utilize more than 40 per cent. of the energy given by the steam engine. But this is quite sufficient to make this system much cheaper than horse traction.

MR. MANSFIELD: I would like to ask Mr. Reckenzaun in regard to the waste of energy necessary to carry the storage batteries. Would it not take as many

batteries in some cases as to make their weight many times the weight of the car? On a level street it would not take so many. Batteries of two horse-power might be sufficient, but on a grade of five per cent. it would be necessary to carry twelve horse-power storage batteries for probably ninety per cent. of the time. Although I understand that the energy of these batteries would not be used except when needed, at the same time they would weigh a great deal when carrying them through the streets. I have figured somewhat on these problems, and I am still inclined to favor the more direct system. I believe that the time arrives in the history of a city when it is necessary that considerations of beauty should be sacrificed for utility. When necessity demands it we can run wires overhead through our streets, and in running the wires overhead you obviate a number of these lesser losses that Mr. Reckenzaun mentions. Then I would like to ask if he would give us any figures that he has in regard to the rate of loss that he would allow on an average load between the power necessary to the passengers themselves and that to propel the car?

Mr. Reckenzaun: In my paper I gave the exact figures of the weights of the entire material used in propulsion and the weight of the car as a whole. I think I stated that the electrical apparatus has one-fifth of the weight of the car when filled with passengers. Then Mr. Mansfield says that we have to carry 12 horse-power batteries, because occasionally that power is required. Now, it is well known that we can discharge the storage battery *ad libitum*, at the rate of 2 amperes or 200 amperes. I can get out of a storage

battery almost any horse-power I like for a short space of time. I have not the least objection to the direct system. But when you come to run twenty or thirty or fifty cars on one line, you will require very large conductors or dangerously high electromotive force. The overhead system is applicable to its own particular purposes. Where there are only five or ten, or even twenty cars, running on one line, and that line runs through a suburb or a part of a city where there are not many houses, that system is to be preferred. The objection to the overhead system is not so much the want of beauty, but the want of practicability. You have to put your posts very high indeed so as to let great wagon-loads of hay and all sorts of things pass underneath. Most of the trouble comes in winter, and when it is snowing hard a great many difficulties arise. As regards the loss, suppose that the resistance of the overhead lines is one ohm. To draw one car it will take an average of 20 amperes, and the only loss will be 20 multiplied by 20, that is 400 watts through line resistance. But if there are ten cars, on that line you get 40,000 watts loss of energy, unless you increase the conductor in proportion to the number of cars. If you do that you get an enormous conductor, and have a sort of elevated railroad instead of a telegraph wire, as most people imagine an overhead conductor to be.

MR. RECKENZAUN said further in answer to a question put by Mr. Smith: The current required to run a street car is about thirty amperes, and an electromotive force of above 180 volts. If cars are run in connection with an incandescent light station, we can arrange our apparatus so that we can use an E. M. F. say of 110 volts,

and then we can put in a smaller number of cells with a larger capacity that will give a corresponding horse-power. We can charge such larger cells with 50 or 60 amperes instead of thirty.

In regard to arc lighting machinery, the arc lighting dynamo should not be used to charge the accumulators. They can be used, but they require such constant attention as to make them impracticable. We can only use shunt-wound dynamos conveniently for that purpose.

MR. PENDLETON: I understood that the loss of power in drawing the cables in Philadelphia was ascertained at 50 per cent. In San Francisco it was 68 per cent. used in drawing the tables, 28 per cent. in operating the cars and 4 per cent. in carrying passengers. In the remarks made by Mr. Reckenzaun I understood him to say that he considered the shunt-wound dynamo essential in charging the storage battery.

I have had in continual use a dynamo for the purpose of charging storage batteries, but I found it necessary to use a current breaker in order to avoid the reversal of the dynamo, which at one time bothered me a good deal. I think perhaps there is no other difficulty whatever in using any ordinary series dynamo, although the shunt-wound dynamo has certain advantages for general use.

I am reminded by hearing Mr. Mansfield speak of the direct system of transmission, that about a year ago I was asked the question by the board of directors of the Brooklyn City Railway, what the difference in cost was between the direct transmission of electricity for the purpose of propelling cars and the storage battery. It

was a complex question, and I felt that it could be solved by a diagram more readily than by language. Therefore, I drew two parallel lines of rails supposed to be five miles in extent, and I pointed out that the resistance of the circuit when it reached a sum to divide the power developed at the station would make the secondary battery beyond that the most economical. On one occasion, before the New York Electrical Society, where we were debating the subject, I mentioned a method which I had of using direct transmission near the station, charging the batteries and operating the motor by means of a combination of the battery, and then utilizing the electrical energy at the extreme ends of the route. A storage battery might be able to work far more usefully than by merely exhausting a charged cell. I believe that, under the circumstances, a secondary battery can be made to operate a car for a day of fifteen hours without removal, and only required to be removed when, by extra discharges, the motor became heated or required attention in the battery hospital, which every car station must have.

Mr. Mailloux: I might say that I am myself largely interested in the problem of street car traction with accumulators, inasmuch as I happen to be consulting electrician for the company which I believe put the first street car propelled by accumulators into commission—a car run on the Madison and Fourth avenue lines in New York City. Some of the data which I add by way of corroboration or comparison with those of my friend Mr. Reckenzaun might, perhaps, be interesting. The grades on that line, as some of you may know, are extremely severe; not only that,

but they are long, so that they tax not only the capacity of the motor, but that of the battery very severely. We have on one part of the line a grade of nearly 5 1-2 per cent., and there are a number of grades as high as 4 per cent. Besides that, in several places the grades happen to be on curves, which add greatly to the effort required by the motor to propel the car. We have found that it was preferable to use two motors instead of one. We think it would be better to use motors rather larger than necessary in order to obtain larger efforts with a comparatively high efficiency. We use 130 cells, which weigh somewhere in the neighborhood of 3,000 pounds. The whole car, with the motor and batteries, weighs as nearly as possible about six tons without passengers. This weight is altogether excessive, for the reason that the car has very strong iron beams. It was strengthened in Europe before it was sent over here, with the idea that we might want to carry enormous weights upon it.

One of the other questions that I wished to ask Mr. Reckenzaun was as to the amount of electrical energy per mile, that he finds necessary. I have found as the result of repeated observations that we must count upon an electrical supply of energy equivalent to from one to one and two-tenths electrical horse-power per car mile. This means that if we have a supply of electrical energy equal to, say, 40 electrical horse-power hours, we have enough energy to run somewhere between 35 and 40 miles. In practice we do not deem it expedient to exhaust completely the capacity of the car, and we find that a run of 30 to 35 miles is all that it is best to make in the ordinary everyday work of a

car. We find, therefore, that in the average day's run of 60 or 70 miles it is necessary to change the accumulators twice a day. The car would start with a charge in the morning and would change somewhere about the middle of its work, irrespective of the number of hours it had been in operation, because the number of hours run includes the stops. You will see, therefore, that the mere time necessary for changing the batteries becomes quite insignificant when there are only two sets of them to be changed in one day. So that I do not think the objection advanced by Mr. Pendleton has very much force, in this case at least.

The question of transmitting the power from the axle of the motor shaft to the wheel shaft is one that has received a great deal of attention. I know that Mr. Reckenzaun has gone over that subject very carefully in Europe, and that he has some original plans and systems of his own. I think it would be very interesting if he would tell us of his experience.

In one system we have found it preferable to use a counter shafting in order to reduce the speed of the motor, but the reduction which we obtain is perhaps larger than it would be in regular practice. We reduce in the ratio of nearly one in ten. In other words, the motor runs nearly ten times as fast as the shafting.

In considering the expediency of a change, it becomes an important question to determine how quickly and how rapidly that change shall be made. It is there that the secondary battery system presents undoubtedly great advantages. If this system is to be operated by any overhead conductor or underground conductor, it is

necessary that we should go at once to the expense of organizing the system of conductors completely from one end to the other. We must provide facilities before we can run one car for establishing a circuit for as many conductors as may be necessary. It does not matter whether part of the system is operated by storage or part by horses, because they are independent of each other. The only thing that we have found in practice is that we have to be careful not to run into the other cars, because there is one point which you must bear in mind, which is this, that just the same as the electric light, when it first came, not only gave us cheaper light but gave us more of it, so the electric street car system not only gives us very good locomotion, but gives us very much better speed. Now, in the upper part of the road in which we have this system there is a suburban end which extends from Eighty-sixth street to Harlem. There are very severe grades there, but the patronage is not very large, and is more suburban than anything else. There they run some thirteen cars. Now, the superintendent of the road, with whom I happened to be on the car one day when they were making experiments, told me voluntarily that with the electrical storage system it would be possible to give the people in that neighbourhood something very close to rapid transit. It would be possible to run all the cars at a much faster rate of speed—it would be permissible, under certain conditions when it is remembered that the line is almost entirely in the suburbs of the city—and in that way the time of making the trip would be very much shortened. We found that we could very easily attain a speed of twelve miles an hour.

Of course we are not at liberty to make very lengthy runs at that speed, but we have experimented with the line duing the night several times, when the tracks were entirely free, and in that way we have been able to determine pretty accurately the rate of speed that might be maintained.

In regard to the charging of storage batteries by arc light circuits, there is perhaps some misapprehension in my friend's mind. I do not think that with small dynamos it would be possible to use them; but in speaking of charging storage batteries as we understand it, commercially, it would no doubt refer to a few storage cells off an arc light circuit. As the E. M. F. of the battery would be very much smaller in comparison with that kind of dynamo-electric machine, there would be no difficulty whatever. The only disadvantage is that of the low rate of current to which the arc light circuit has gradually been dwindling, and we find that in a great many cases it is not more than 6 1-2 amperes. In that case it would take something like between 22 and 24 hours to effect a complete charge.

Now there is another important thing in relation to the electric railroad. It is the question of braking the momentum by electricity. I found that railroad men, as conservative as they are, when once they conclude to adopt electricity like to have everything done by electricity on the car; and one of the first questions which they propounded was as to the practicability of braking the momentum by electricity. I know of an electrician who proposed to use the motor in charging a battery while descending a grade, which would produce an intermittent charging. I confess that I do not

see very much margin to be expected from this, judging from what has been developed up to the present time, in the way of economy or gain; but I should be interested in hearing the views of so experienced an electrician as Mr. Reckenzaun on that subject. With the car that we are running on Fourth Avenue, we we enabled to run up a high grade with a load of some thirty passengers, with an additional car attached containing some few passengers more. But the superintendent was not satisfied with that. He made a stop on the grade, and, after stopping, a start was accomplished without any difficulty.

MR. RECKENZAUN: In regard to using two motors on a car, there are several advantages in it. I use two motors on all my cars in Europe, and always have done so from the beginning. One of the advantages is, that in case of an accident to one motor the other will bring the car home; secondly, with two motors we can vary the speed without changing the E.M.F. of the battery. If I want very much power I put two motors in parallel, getting four times the power that I do with one machine, and an intermediate power of two motors. There is another advantage of having two motors, and that is that we can use two driving axles instead of one, and we can go up grades with almost double the facility that way, because the adhesion would be double. These are the main advantages arising from the use of two or more motors. Mr. Mailloux asked if I would give my experience in regard to the mechanical transmission between the motor and the car axle. I have used almost everything that was known at the time, but in order to give you a full and detailed account of

the various modes of transmission which I have used I should have to give you figures to bear out certain experiments. I should only be able to do that in a lecture of at least five hours' duration, so I hope that you will kindly excuse me on that point.

With regard to the durability of plates, I have taken into consideration fifteen hours a day. In regard to the application of electrical brakes, I will say that that was one of the first ideas that entered my head when I began to use electric motors, and other people had that idea long before me. I have used an electric brake, using the motor itself as a brake—that is, as the car runs down a grade by momentum it generates a current, but this current cannot be used for recharging a battery. It is utter nonsense to talk about that unless we have a steady grade four or five miles long. The advantages are very small indeed, and the complications which would be introduced by employing automatic cut-outs, governors, and so on, would counterbalance anything that might be gained. As regards going up an incline, of course stopping and starting again has to be done often, and anybody who at any time works cars by electricity, whether they have storage batteries or not, has to allow for sufficient motive power to overcome all the difficulties that any line might present. One of the great mistakes which some of the pioneers in this direction made was that they did not put sufficient power upon the cars. You always ought to put on the cars power capable of exerting perhaps 20 to 40 per cent. more than is necessary in the ordinary street service, so that in case of the road being snowed up, or in the case of any other accident which is liable to

occur, you ought to have plenty of power to get out of the scrape. Mr. Pendleton made certain suggestions in regard to a combined system of conductors and accumulators. I do not know much about those, and I could not give an opinion unless I had studied the matter thoroughly.

MR. KINSMAN: What would be the effect on an accumulator of intermittent charges such as the gentleman spoke of, in going down grades?

MR. MAILLOUX: It would not have any bad effects so far as that is concerned. It is merely a question of the expediency of the process—whether there would be sufficient energy gained by it to make it worth while.

MR. KINSMAN: The point I wanted to make was: Are intermittent charges economical and desirable?

MR. MAILLOUX: I do not think it matters very much whether the current be intermittent or not. There may be a slight difference in fluctuation of the electromotive force by virtue of the variation of the rate of charge, and that might affect the efficiency of the storage battery as an instrument for conversion—but it would not effect its storing capacity to any appreciable extent.

MR. MARTIN: I think we have all listened with pleasure to Mr. Reckenzaun's outlining of his experience. Mr. Reckenzaun is among us for a very short time. We have already in our ranks several distinguished European electricians as honorary members, and I would like the opportunity of offering the resolution that we receive Mr. Reckenzaun into our ranks as an honorary member.

THE PRESIDENT: Mr. Reckenzaun is already an active member. There is more honor in that than in being an honorary member.

Mr. RECKENZAUN: I can only express my feelings of gratitude for the honor conferred upon me. I am quite sure I do not deserve it.

The President then called on Mr. Duncan for his report on electric motors.

MR. DUNCAN: At the last meeting a committee was appointed to prepare statistics in regard to the number of motors in operation at central light stations, the prices paid, and so on. A circular was issued; some of the companies responded but a very large proportion did not respond. There is, however, in the hands of the committee a large amount of valuable information which a member of the committee in New York who paid particular attention to the New England States promised to bring to this place on Monday evening and to meet with the other members of the committee. However, that information and the gentleman himself have not turned up to the present time, and the papers I have contain some information which I do not think should be published unless through the hands of the Executive Committee. It gives in those reports such statistical information regarding charges and so on of some of the local companies which it might not be judicious to spread out for general information, and therefore instead of preparing a written report, after consulting some of the members of the Convention, I ask the privilege of making a motion to refer those papers to the Executive Committee so that they shall pass upon them, procure such data from them as they

may think best and to have that paper then distributed for information. I make that motion and I ask for the discharge of the committee.

The motion was carried and the committee was discharged.

The committee on the next place of meeting presented a resolution that the next meeting be held in Pittsburgh at such date in February as the Executive Committee might determine. The resolution was adopted.

THE PRESIDENT: I call for the report of the Committee on Nominations.

DR. MOSES: May I have the floor for just one instant. In order to avoid what would look like a tautological action it is necessary that there should be at least one vacancy. I happened to have the honor of being appointed a member of the Executive Committee for one year, of which one-half the time has elapsed; but as it is very important that the Executive Committee should be appointed as much as possible from the neighborhood of the place where we are going to hold our next meeting I thought it would be advantageous for me to have some one substituted for myself, and, therefore, I beg to tender my resignation as a member of the Executive Committee.

Dr. Moses' resignation was accepted.

Resignations from membership in the Executive Committee were read from Messrs. Stephen Holbrook and F. A. Gilbert, which were accepted.

Mr. S. A. Duncan, of Cleveland, (nominated by Mr. DeCamp), Mr. T. Carpenter Smith, of Allegheny City, (nominated by Mr. Lynch), Mr. Wells W. Leggett, of Detroit, (nominated by Dr. Moses), were elected as

members of the Executive Committee in place of those resigning, the ballot of the Association being cast by the Secretary for the persons nominated.

MR. LEGGETT: I believe that it was stated at the opening of the meeting that we would take up this matter of underground wires at the close of the session. I desire to state what position we are in at Detroit. At Detroit, as most of you gentlemen are aware, having seen our city, we are lighted by the tower system. We have some four hundred miles of wires in our system there. Just at the present time our City Council, our Board of Trade, and our Mayor all of them very excellent gentlemen who have at heart the welfare of our city (and there is no question but that they have at heart also the welfare of our company), have deemed it expedient on their part to immediently stop the operation of running the wires overhead. Now, we are met with this condition of affairs, that we do not know what to adopt. We would be very glad to have the views of this convention, or the views of such members of it as have had experience in this line, and to know if there is any system which any one can recommend that is beyond the experimental stage. We have invested in the city of Detroit nearly half a million of dollars in our plant, and you can readily see that we are driven to an extremity. That, of course, to us, is a matter of very grave importance. We want to know whether we are obliged to take one of a number of things, each of which is experimental, or whether there is some system which some person, some member of this association, can say that he has found to be expedient and practicable throughout for this purpose.

I must confess that after all our investigations in this matter we are as yet entirely undecided to know what to do. We recognize as well as our Mayor, our Board of Public Works and our City Council, that this matter of overhead wire is becoming a very serious one, interfering with fire ladders, causing more or less danger to property and to person, but the remedy is what we are seeking. If there is anything which we can adopt, we would be very glad to adopt it; and for that reason I hope that there will be short remarks from a number of sources, the experience of different individuals in this line, whether there is anything that they can recommend directly; and I should also be glad to know of the difficulties that they had experienced in regard to the matter. I would like very much if Mr. DeCamp would state briefly whatever experience he may have had with the matter in Philadelphia; and, if we have a representative in the room from the city of Brooklyn, I would also like to hear from him.

MR. DECAMP: All that I can do is to state the facts of the case as it exists in Philadelphia. As Mr. Leggett says, it is certainly, with us, not beyond the experimental stage. There has probably been more work done in that direction in the city of Philadelphia than in any other city in the country, and this is the condition of it. The department known as the electrical department of the city of Philadelphia, about a year and a half ago, made an appropriation of $5,000 to put down a line about one mile long. A lead-cased cable was laid, well insulated, put in a trough which was filled up with residuum of petroleum. That car-

ried 12 lights of 30 volts each, which was the extent of that particular line.

At the end of a year a further appropriation permitted the department to extend its line. It, however, was not extended in a double line. The balance of the circuit was made on one side of the circuit, and the other was taken overhead. That has been in operation about six months. It is now carrying a load of lamps of 45 volts each, and has been doing that for probably the last three months. The cable is working fairly well, but from various causes has had more or less grounds on it, very many more than the overhead circuit. Additional experience was recently had at South street, where there was a circuit of one mile put in. The first circuit put in was taken up for some reason or other, it being a failure. The cable, which is there to-day, is a good one, but the superintendent tells me that the grounds are so numerous that he hardly knows where he commences to pick them out; and there they are to-day in that condition. Whether it is the fault of the cable or of the conduit or of the work done I do not know. That, however, has brought us to this conclusion, that we have got to replace all of that before we shall be justified in running lines over such a circuit.

The sectional underground wire operated by the Electric Light and Power Company, of which company I am the manager, is the latest experiment in the way of underground electric lighting which we have in Philadelphia. I have been manager of that company for six months. The gentleman in charge of that is a clever man, and a man of more practical experience in the operation of underground wire, I think, than almost

any other man in the country. He is a man of exceptional intelligence, and is an enthusiast in his work. He has left no stone unturned to look into the difficulties which we have experienced and to try and foresee them. The conduct itself I believe to be one the best structures in existence. I am speaking now merely for its convenience. It is an iron conduct. Previous to my taking charge of it, I do not know how many cables they had in; I do not know how they were selected, but certainly with best judgment that the company then possessed.

The Superintendent made the best of what he had, and they are constantly troubled with them. They never had a sound circuit from one year to another. When I went into the management, I went over the matter very carefully. They had had some five or six explosions of greater or less severity, but fortunately none that did any serious damage. In about two weeks we did have a blow-up which did do some damage. He ventilated it with a blower—blowing through it, not exhausting out of it. I concluded that that was a risk that we, as a lighting company, could not take, and while the station sorely needed the income from the 90 lights running at the time, we abandoned the arc lighting from that station and have now converted it into an incandescent station using 100 volts. The condition of the streets of Philadelphia, particularly the old sections where the gas mains are laid, is such that I find it to be utterly impossible to keep the conduits free from gas. In the City of Chicago, I am told, they are troubled with gas in their conduits, and I hear that the City of Brooklyn had had two or three explosions in connection

with its telephone service. Therefore, I am forced to the conclusion that conduits in the city of Philadelphia, at least, will have to be abandoned—open conduits. The cost would make them prohibitory. I am not sure that they would be successful, but it looks reasonable that they would be, if that amount of money could be spent on them. As a matter of information backed by what little experience we have in that line I want to say that our use of any metallic covered cable has not been encouraging. We have had a great deal of trouble with it. There seems to be a disposition of the current—reactionary current or something on account of the lead casing which makes it very difficult to handle at the termials, and that accounts for a great many of the grounds that we have on that line. But certain it is that if the matter was left to me and I had to decide it, as a manager of six years' standing held accountable to my company for the proper use of their capital, if left entirely to me I could not justify the expenditure of any such sum of money on the knowledge that we have of putting wires underground to-day.

Mr. Brown (Chicago): I have had about eighteen months experience with underground work in Chicago and would agree with Mr. DeCamp in a great many things that he has mentioned, but hardly in all. We have the Dorsett conduit there and we are troubled greatly with gas and have had one or two explosions, although they have not caused much damage. We find that the principal trouble with the conduit is at the joint. We think that if a perfectly tight joint could be made between the section that we would not have so much trouble with gas and even water that leaks in.

The newest conduit to-day of which we know is the Hurlburt conduit which has a flexible joint. I do not know that any of it has been laid. It has been on the market but a short time, but it seems to me that it would surely carry out their expectations from the fact that the joint is flexible. We have manholes at an average distance of 400 feet apart, and between the manholes we find that the conduit sags after it has been laid any length of time from the pressure from above—the street traffic. I have seen on exhibition this new conduit and the joint is very flexible indeed. It would allow the bending of at least 6 inches in 400 feet and I have seen a joint in water which has been in that condition six months now without any leak at all. We have some sixty or seventy miles of wire underground and in that sixty or seventy miles of wire all classes nearly of cable underground wire are represented. We tried lead covered cable at first and finally thought it was best to give that up but lately have gone back to it. We find that in places lead covered cable fills the bill. We think it is best to make our main circuits running from the station before we reach any lights, of lead with white joints, and after we leave the conduits and run through the laterals under the sidewalk we find it would be best to have something besides lead cables, because as you know on all arc light circuits we have to cut them everywhere and anywhere at all times to put *in* and take out lights. Lead covered cables I do not think hardly fill the bill under the sidewalk. You see there is a dead ground less than a quarter of an inch away from the main circuit and as we run through the areaways the cable is subjected to injury. People use

that place for storage and this lead cable is injured in every conceivable way. If it is dented or broken the least bit we soon have dead ground. But we find it necessary to have white joints on the lead cable and when we do leave the conduit to leave lead cable for good and put in some other. We also have great annoyance from the rats. They eat the lead of the cable and we average a dead rat a week. You can see where their feet and their tails burn on the cables and we find them on the ground with their noses burnt off.

MR. POWERS: I have been in the past year somewhat interested in this underground system. The principal cities of the state of New York, outside of New York and Brooklyn have been greatly exercised during the past year on account of the interference of the wires at the Buffalo Hotel fire with the ladders of the firemen, and on account of that a number of bills were introduced and two or three were passed by the legislature and signed by the Governor allowing wires to be introduced underground with the consent of the local authorities. We told the Contract Board of the City of Troy that we would break our contract and would make no contract with them under any condition that did not contain a clause eliminating the underground business. In other words, that our contract should be binding as long as our wires were overhead. Unless we are to have a great deal of trouble in the smaller cities especially, it is necessary for the electric light men to take an uncompromising attitude. People say because we want the wires underground that is good reason why they must go. That is all they know about it. A prominent

paper of the State of New York, one of the most prominent papers of this State, actually urged as an argument that because an Edison company in the City of Albany put their wires underground we in the City of Troy should put our wires underground. Now, in that state of ignorance it is the business of this Convention to enlighten people on that subject as much as possible, and also to take the most uncompromising attitude toward forcing the wires underground. Let them understand it is not possible, in the present state of the art especially, where lights are spread over a large area.

MR. DECAMP: Mr. Powers calls to my mind a little early experience I had with legislative matters. About the first year that we started there was a bill brought up in our council taxing overhead wires. It was first put at ten dollars a mile for telephone and telegraph wire and fifteen dollars a mile for electric light wire. However they reduced it to $2.50 for telephone and telegraph wire and $5 a mile for electric light wire. I said: Gentlemen, I do not understand why an electric light wire should be taxed more per mile than telephone wire. One of the members turned around and said: "What is your name? Where are you from?" He then moved that they amend that by making the tax on the electric light wires $15 a mile. That is the way your argument, so far as this is concerned, is met.

MR. SMITH (Jamestown, N.Y.): Was that passed?

MR. DECAMP: It was not passed.

MR. POWERS: The point I am insisting on is that the people do not understand it. They regard the

matter of putting wires underground as an everyday occurrence like putting the gas mains underground. If this Association can speak with authority on that subject I am sure it will help some one when they need help in the matter.

The Secretary read the following from Mr. F. E. Kinsman:

"Cannot the question of protection for lighting arresters be considered at the next meeting of this body?"

THE PRESIDENT: If Mr. Kinsman will talk with Mr. Keilholtz, of Baltimore, he will get some very valuable points on that very subject.

MR. LEGGETT: I would like very much to hear from the President on this subject and to learn what experience he has had in Baltimore.

THE PRESIDENT: We have not had any. I have declined for a good many years going before legislative or municipal committees for the simple reason that it is only a question of cost as to the feasibility of placing wires underground. It is a question I do not care to debate because we do not want to put our wires underground. It costs too much.

MR. LEGGETT: That is just the information I wanted to arrive at.

THE PRESIDENT: Very expensive, sir, but entirely feasible.

MR. LAW: As in Philadelphia we have had considerable trouble in conduits from the explosion of gas I would like to ask the gentleman from Chicago if he has made any experiments in drawing gas from the conduits. In Philadelphia our lights are erected on

iron poles made of gas pipe and in two places lately we have cut holes in those poles and connected them with the conduit. I notice that there is considerable escape of gas from the top of those poles. I was up one of them the other day examining it, and it was very perceptible there—quite strong and I would like to ask if there have been any experiments made in that direction.

Dr. Moses: There is a little matter but one of great importance, as trifles are sometimes the most important things. There is a little thing that might be reported upon to this Convention at some future meeting with advantage. It is a report on the influence of electric currents, both continuous and alternating, on small masses of magnetic matter and on the demagnetization of the same. That is intended to cover the question of the rapid magnetization and demagnetization of small masses of iron used in measuring instruments for various currents, and also what is the effect of currents large and small upon watches which are in everybody's pocket and whether it is possible for them to be demagnetized when once they are really magnetized, by any appliances that we have. It is a question of great importance. When you consider that when the first chronometer that went accurately was the means of bringing the inventor a reward of twenty thousand pounds from the Britrish Government you can see it is a matter of importance to have time pieces absolutely accurate for certain purposes. All of the chronometers used on board ship contain masses of iron in them, and it is a very important thing that somebody shall not come down on an electric light

company for the magnetization of a chronometer which caused the loss of a ship.

Dr. Moses' motion was carried and the Chair appointed Mr. E. Lange of Pittsburg on the committee.

THE PRESIDENT: I will appoint on the Committee on Insulation, etc., to take the places of those who resigned, Professor Thomson of Boston, Dr. Otto Moses of New York, Dr. L. Waldo of New Haven, Dr. Duncau, Baltimore, E. Lockwood of New York, George Hamilton of New York, O. N. Shallenburger of Pittsburg.

PROFESSOR THOMSON: I thank the President for the honor of being appointed on that committee. I will endeavor to collect all the information I can in regard to those subjects with the assistance of the other members of the committee.

MR. DUNCAN: If there is no other business before we adjourn, I would just like to call the attention of the Convention to one point. I was not present yesterday morning when the report of the Carbon Committee was presented, and it seems to me that there is one point which interests local lighting companies which has been passed over without very much consideration, and in that connection it seems to me it would be well to take some action preparatory to the next meeting to look into this question of carbons very thoroughly either through the Executive Committee or some special committee; because, if we have got to break down a pool every two months, we ought to be in shape to do it, and it seems to me that, from the information which has been going around—not in the Convention itself,

but from mouth to mouth—in regard to the formation an organization and the prices desired to be obtain by the old pool, that the time has arrived for the co panies interested here through the committees of t Association and through its proper officers to look af that subject very carefully. It seems that we ha been able in the past to get along very comfortab with the pools, but I can conceive of circumstanc where it might take considerable time to break a combination. If that is the case it seems me it would be well to have either a special committ appointed or the matter referred to the Executive Co mittee to keep it in hand. As I understand, the co mittee that reported yesterday morning was discharge If they were discharged I should make a motion that committee of three or five be appointed to take t matter in hand and that all papers pertaining to carb be referred to that committee for report at the ne meeting, and that they have power at any time to c the attention of the Executive Committee to any pr posed action such as has taken place within the last fe months. I think it is high time that we protect ourselv as well as that the parent companies protect themselv in the manufacture of carbon.

At the request of the president, Mr. Duncan put motion in writing as follows:

Resolved, That a committee of three be appointed the chair to inquire into and report on all matt pertaining to the carbon matter.

The resolution was adopted.

The PRESIDENT then declared the convention journed to meet in Pittsburgh on a date in February be hereafter determined by the Executive Committe

CONVENTION

OF THE

National Electric Light Association

HELD AT PITTSBURGH, PA.,

February 21st, 22nd and 23rd, 1888.

FIRST DAY'S PROCEEDINGS.

The Fourth Annual Convention was called to order at 12 M., on February 21st, by the President of the Association, Mr. J. F. Morrison, of Baltimore.

The President addressed the convention as follows:

Gentlemen of the Convention: When the National Electric Light Association, in its wisdom, decreed that its next meeting should be held in this city, it was certainly an evidence of our faith in the stability of the business in which we are engaged.

The cheapest of coal, the natural gas—every element that nature could furnish for illuminating purposes is here spread out freely, without money and without price.

To face these existing conditions, the electric light, which is comparatively expensive, must have behind it the backing of nerve and courage and an unbounded faith in the good taste of the people of Pittsburgh, who, with its greater cost, have adopted it in preference to

hat of its mighty competitors; that light which not only illuminates but adorns their dwellings, their mercantile houses and their public buildings.

Seven years ago the first electric lighting company was started in Pittsburgh with 14 arc lights. It struggled along against the prejudice, against time-honored usages, for six years, at which time 300 lights were burning where there had been one. Here a new era opened, and within the short space of 18 months the electric lighting business increased to 350 arc, and 20,000 incandescent lights, which now blaze in a constellation of glory, reflecting credit upon its progenitors. During the past six months we find that great progress has been made in cheapening the methods by which electric lighting is produced. This is noticeably the case in the arc lighting business.

The extension of arc lighting since our last meeting has been something marvelous, while even that has been outstripped by incandescent lighting, both by direct and alternating systems.

There are today in this country at least 3,000 isolate arc or incandescent plants and over 1,000 central stations. At our last annual meeting there were in operation in the United States, approximately, 125,000 arc lights. Since that time there have been installed and contracted for probably 50,000, bringing the present actual total within the neighborhood of 175,000 arc lights.

The number of incandescent lights at our last meeting was slightly over a million and a quarter. The installations and contracts made since that time are reported to foot up nearly half a million, bringing the

present total to about 1,750,000, giving, it will be noticed, on the whole business, a proportion of ten incandescent to one arc. These are statistics which exhibit extraordinary growth and yet are conservatively estimated.

I beg again to urge upon the members of this Association, the necessity of intelligent and well directed efforts toward the more perfect construction of lines and installation of apparatus. While some fatal accidents have marred the record of the past six months, I am glad to say that they have been fewer in number and less chargeable to the danger of the system itself than have been similar casualties in any other calling that involves the use of power-driven machinery.

The attendance at this meeting is sufficient evidence of the success of this Association. The Secretary's report shows a membership of 168. By reference to the report of the Treasurer we find that a fairly good financial showing is made.

With a debt of only $98 and with $971 in the treasury to cover all expenses of the present fiscal year, we need have no fears on that score.

Considerable progress has been made by Arthur Steuart, Chairman of the Legal Committee, toward bettering our condition in the Patent Office. This is a matter to which your attention will be strongly directed during this present convention, and I ask for it your calm and careful consideration. You will be called upon to decide whether or not further steps shall be taken in the direction already pursued. I am seriously of the opinion that for the better protection of those in the electric lighting field whose first investments depend

largely upon the validity of their patents we should, if it is possible to do so, prosecute to a successful conclusion a work so well begun by the Legal Committee.

Papers will be read as follows, on "The Practical Side of the Distribution of Alternating Currents from Central Stations," Mr. T. C. Smith, Pittsburgh; on "Underground Conduits for Arc Light Wires," Mr. W. W. Leggett and Mr. Jesse M. Smith, Detroit; on "Electric Motors," Dr. G. A. Liebig Baltimore; on "The Economic Value of Steam Pressure Records," Jarvis B. Edson, M. E., New York; on "Leather Belting, its Origin and Progress," Mr. Charles A. Schieren, New York; on "Independent Engines in Incandescent Light Stations," Mr. W. Lee Church, Pittsburgh; on "How Can We Protect our Watches from Magnetic Influences?" Dr. Philip Lange, Pittsburgh.

Permit me to congratulate the association upon the excellent work done by Mr. Duncan, Chairman of the Executive Committee, who has been so ably assisted by his colleagues, and who has shown his signal executive capacity by the excellent manner in which he has prepared for the prompt transaction of the business of the association, and for the comfort of its members.

I desire to call your attention to one or two points which reflect a great deal of credit upon the citizens of our own country, and perhaps, to put it mildly, negligence on the part of those abroad. Statistics show that in this country we have 178,000 arc lamps in service and also a large number of incandescent lights. Now, the question naturally arises, why should we have made such headway on this side of the Atlantic and why should the business have been practically at a

standstill on the other side? The answer may be given in two words—vicious legislation. If one absolutely inimical to progress had planned out an act of Parliament which would have absolutely quenched electric lights in Great Britain and Europe he could not have better succeeded than those who framed that infamous act known as the Parliamentary Lighting Act, which has paralyzed that industry, has smothered invention in that direction, and which finds its only vent in the spleen which casts slurs upon those of us on this side of the Atlantic who have been diligently engaged in procuring this light which has been so popular amongst all classes of our people. A few years ago it was only the rich who could enjoy this luxury. To-day, it is brought to the door of the poor man's house, and within a year or two more it will be the popular light which will not only take the place of the illumination by gas but will take the place of the coal oil lamp and will be within the reach of every one who is capable of reading and who is desirous of using the electric light for that or any other purpose.

I now have the pleasure of introducing to you Major W. C. Moreland who will offer you the privileges of the city of Pittsburgh. Some of you have taken advantage of the privileges of the city of Pittsburgh last night, I think. Gentlemen of the Convention—Major Moreland.

Major Moreland then addressed the convention as follows:

Mr. President and Gentlemen of the Convention: I cannot present myself in the shape of a bouquet nor can I hope to receive your flattering encomiums by my

personal appearance. I have been requested by the Mayor of the city of Pittsburgh to give you a welcome to this city. To me it is a personal pleasure thus to speak—first, because I have a warm personal interest in all the men connected with the development of electricity in all of its parts, and because in this convention there sits a man who, 40 years ago, was my master and my boss—taught me how to carry a telegraph line—how to make a connection; taught me something about a magnet, a little bit about an instrument and asked me on one occasion to go—not very far from where we are sitting to see whether the lines were not broken between two poles; told me how I could test whether or not the connection existed between those two poles, by putting the two ends of the wire to my tongue. I did it, gentlemen, and fell over the hill. (Laughter). I sat opposite him when the first telegraphic communication between New York City and New Orleans ever passed over this part of the continent. I heard him say that he had carried the wires through the marshes of Louisiana along through the whole of the South to Louisville; from Louisville to Cincinnati, from Cincinnati to Pittsburgh, and at Pittsburgh he stopped to see whether the Eastern connection was correct or not—my friend David Brooks, the man who introduced electricity into the City of Pittsburgh and made the first connection ever known in this country by wires connecting the extreme East and the extreme South. [Applause.] I have, in addition to that, gentlemen, a personal pleasure in asking your attention to the industries of the City of Pittsburgh. If you have leisure to examine them they are worthy of your study, and we

are glad that such a convention as this has assembled in our city, representing as it does not only experimental, but great brain power. You have solved the great problem that was in the mind of Benjamin Franklin, who claimed that electricity was at last to be subordinated to the uses of man. You have brought it to our homes, you have brought it to our industries, and who can tell where, with your industry, your brain, your perseverance, it may at last land? It has now become not only a commodity but a pleasure at our homes and firesides, and after a while it may be that we of today may be laughed at as being in the very incipiency of the power of electricity. Gentlemen, I have a personal pleasure in meeting you, not only because I was once an electrician myself—that is to say, a novice in electricity—but one who sympathizes with the progress made during the last 30 years of time, and secondly because you are right in the place where of all other places we want electricity practically applied. I know nothing about your purposes — nothing about the progress your society has made; but in the name of the city of Pittsburgh, as the representative of its mayor, I bid you a most hearty welcome and am glad to say to you that after the election is over to-day, every place will be open for the convention. (Applause).

THE PRESIDENT: I now declare this convention open for the transaction of business. The first business in order will be the reading of correspondence.

The Secretary read a letter from Mr. G. S. Bowen expressing his regret at being unable to attend the convention; also a letter from Mr. F. C. Osborn, Chairman of the committee on progress of the Engineers'

Society of Western Pennsylvania inviting the members of the Association to attend a meeting of that society at 8 o'clock in the evening,

On motion of Mr. Duncan it was agreed that the invitation be accepted and that the Association attend the meeting of the Engineers' Society.

MR. DUNCAN: I move further, sir, that an invitation be extended to the Engineers's Society of Western Pennsylvania to attend the sessions of this convention at their convenience, and participate, if they so desire, in the discussion which may take place.

The motion was carried.

A letter was read from the Allegheny County Light Company inviting the members to visit the station of that company. On motion the invitation was accepted. A similar invitation from the Westinghouse Machine Company was read and accepted.

A telegram was read from Mr. H. C. Davis, President of the Electric Club of New York, tendering to the association the use of the Club House in the event of their holding the next convention in the city of New York.

On motion of Mr. DeCamp the communication was referred to the committee to be appointed to name the place for the next meeting of the association.

A letter was read signed by several Westinghouse sub-companies enclosing a contribution by those companies of $1150 "To encourage the best interests of the Association."

The communication was, on motion, accepted with the thanks of the convention.

THE SECRETARY PRESENTED HIS REPORT AS FOLLOWS:

Members admitted in Boston - - - - - - -	17
Joined since ,, - - - - - - -	1
	18
Members who have resigned during last year - - -	4
Bills owing by the Association amount to - - - -	$98

There are now 168 members.

On motion the report was accepted.

THE TREASURER PRESENTED THE FOLLOWING REPORT:

RECEIPTS.

August 1, 1887, to balance - - - -	$ 693.15	
Received from Aug. 1, 1887, to Feb. 18, 1888,	1,261.62	
		$1,953.77

DISBURSEMENTS.

From Aug. 1, 1887, to Feb. 18, 1888, - - -	$982.10
	$971.67

TREASURER'S REPORT OF SPECIAL FUND LEGAL CCOMMITTEE BY SPECIAL CONTRIBUTIONS.

RECEIPTS

From Dec. 12, 1887, to Feb. 18, 1888 - - -	$583.00

DISBURSEMENTS.

From Oct. 26, 1887, to Feb. 18, 1888 - - -	332.19
	$250.81

On motion the report was accepted.

The report of the Chairman of the Executive Committee was read by Mr. Duncan, and is as follows:

REPORT OF MEETING OF THE EXECUTIVE COMMITTEE.

FEBRUARY 20, 1888.

The Executive Committee of the National Electric Light Association met at 12.25 p. m. at the Monongahela House, Pittsburgh.

The following members were present: Chairman, S. A. Duncan; Messrs. Smith, Lynch, Ridlon, DeCamp, and Weeks. There were also present Mr. J. F. Morrison, President of the Association, and W. H. Harding, Secretary of same, members *ex-officio*.

A letter was read from Mr. Noonan regretting that he probably could not be present at the Convention, and that he would be unable to serve any longer.

The minutes of the last meeting of the Executive Committee were read and approved.

The report of the Secretary and Treasurer was read, and on motion of Mr. Morrison, was referred to an Auditing Committee to be composed of three members. The Chair appointed as this Committee, Messrs. DeCamp, Weeks and Ridlon.

The list of delinquents in the matter of dues was read, and, after a full discussion as to the best course to be adopted, it was decided, on motion of Mr. DeCamp, to submit the list to the Association, with the recommendation that said delinquents be notified at once that they are in arrears, and that they be dropped from the roll of members if, after the expiration of thirty days, their dues are still unpaid.

Mr. Duncan then submitted in writing an amendment to Article VIII. of the Constitution, increasing the dues to $25.00 per year.

MR. DE CAMP: I am in favor of increasing the membership fee, but have formed no opinion as to how much; how do the receipts under the present system compare with the expenditures, taking into consideration some increase in the future?

MR. HARDING: At the end of each meeting after paying off bills we have not enough money to publish the report of the proceedings of the Association.

MR. DE CAMP: This is a proper expense, and the proceedings should be published.

MR. HARDING: There are now the proceedings of four meetings unpublished.

MR. RIDLON: Was there not a proposition from Modern Light and Heat before this committee in Baltimore as to the printing of these proceedings at a reduced cost?

MR. DUNCAN: Yes sir: A proposition to which the Electrical World objected, after which the proposition was withdrawn.

MR. Weeks: I think it is important that they be published as soon as possible.

In regard to accepting offers from newspaper men to publish the proceedings, Mr. Morrison said that this Association must be a big thing or nothing, and it should not depend upon any newspaper or newspaper man for the publication of its proceedings, unless such a special case as that considered at the last meeting of the Executive Committee should again occur.

Mr. Morrison thought the Association would be better off at the end of this meeting than ever before,—financially. Mr. Harding called his attention to the fact that the money being received is for the entire year, and not for this meeting only.

MR. DUNCAN: I will be frank as to why I am i favor of increasing the dues to $25.00. I don't lik this begging business on the part of the Association; think it is old enough and strong enough to do busines on a business basis. If we put it on a business basis we will be able to pay a Secretary and Treasurer salary for his services,—which, you will find, pays; th telephone people find that it pays and other Association likewise.

MR. MORRISON: This is the first time I have bee entirely relieved from the actual manual labor o handling the business of the Association. It has bee done more economically than I would have done it, an better, because Mr. Harding has given it an attentio never given it before. If you decide upon M Harding, who has a better knowledge of the Associa tion than anyone—the President or anyone else—an give him a salary for this work, I feel that you will fin it to your advantage. I offer this as a suggestion because the Association has got to appoint a Secretary

In discussing the amendment to the Constitutio suggested by Mr. Duncan, on which he wished to ge the feeling of the Committee, it was suggested that th proposed amendment be changed from $25.00 t $20.00, which, with Mr. Duncan's permission, wa done.

On motion of Mr. Morrison, all remaining bills wer referred to the Auditing Committee.

On motion it was decided to pay the Secretary $25 and expenses for services rendered for the last si months.

The motion was carried.

The next subject before the Committee was the program for Tuesday's proceedings.

In examining the papers to be read, the Committee did not feel that any one who had been honored with an invitation to read a paper before the Convention, would knowingly advertise any particular firm or goods; but it was possible that some cases might be stated a little broadly, and place the innocent reader of the paper, in a false light before the Convention, and subject to interruption on the floor with its attending embarrassment. It was with a view of avoiding any possible unpleasantness or misconception that the Committee took up one paper after another, discussing any parts of the same that might flavor of advertising.

The program agreed on was:

Opening address of the President.

Address of welcome by Major W. C. Moreland. (The Mayor having been called away to Harrisburg.)

Reading of the minutes of the Executive Committee.

Reading of paper of Committee on Proper Insulation and Installation of Plant.

On completing the examination of the papers to be read, the Committee adjourned.

THE PRESIDENT: The first business growing out of the report of the Executive Committee would be a motion by some member that what they have done shall be approved, and then we can take up their recommendations.

On motion of Mr. H. W. Pope the action of the Executive Committee was approved.

The recommendation of the Executive Committee that delinquent members shall be notified at once that

they are in arrears and that they will be dropped from the rolls after the expiration of thirty days if their dues are not paid, was, on motion, adopted.

MR. DUNCAN: I submitted it in writing, as provided by the constitution, and left with the Secretary, an amendment to the constitution in regard to the question of dues. The dues at the present time are an initiation fee of $10 and yearly dues of $10. It is very evident to the members of this Association that for some time past the Association has omitted to have its reports printed, but the Association has not had the funds to properly proceed with that work and to print them as they should be printed in pamphlet form, and it is only at this meeting that our funds are in such shape that we could possibly proceed with the work. The matter had given rise to considerable debate and discussion, and in order that it might be brought properly before the Association at the right time, I submit the following amendment to Article 8 of the constitution: "That the yearly dues of the Association shall be $20." I submit that as an amendment to Article 8 of the constitution, and ask that it may lie over for consideration until tomorrow morning, to be made the special order of business at our opening meeting tomorrow.

THE PRESIDENT: Gentlemen, you have heard the amendment to the Constitution. If you will refer to Article IX of the Constitution you will find that all amendments to the Constitution shall be presented in writing and referred to a committee to be appointed by the Chair, before being acted upon by the Association; a two-thirds vote of those present shall be necessary to their adoption; and that a ballot on such amendment

may be called for upon the request of five members of the Association. In pursuance of this provision of the Constitution, I will appoint as the committee on this amendment, Mr. Duncan, Dr. Moses and Mr. Weeks.

MR. DUNCAN: Mr. Chairman, I desire to make the following motion which was unanimously recommended by the Executive Committee — that Prof. George Forbes of London, England, be elected as honorary member of this Association.

The motion was carried.

MR. LYNCH: I should like to make a motion for the appointment of a committee of five for the nomination of officers for the ensuing year, said committee to also make a recommendation to the Association for the next place of meeting; the committee to be appointed by the Chair.

The motion is carried.

The report of the Committee on the insulation of wires and construction of plant was read by the Secretary, and is as follows:

REPORT OF THE COMMITTEE ON INSULATION OF WIRES AND CONSTRUCTION OF PLANT.

To the National Electric Light Association:

GENTLEMEN: Your Committee begs leave to submit the following report:

Owing to the distance separating the various members of the Committee it has been impossible to hold a meeting during the period intervening between the August meeting in 1887 and the February meeting in 1888. No action of a concerted nature has, therefore, been possible. The Chairman has, however, so far as

other engagements would permit, started some work of collecting different samples of insulated wire claimed to be suitable for overhead lines, which, after exposure to weather, will be tested for freedom from faults or cracks in the insulation.

They will also be submitted to bending and abrasion with a view of finding the mechanical nature of the covering. The Committee recognizes the fact that wires for overhead work to be called good must have certain properties which can only approximately be determined by laboratory tests, since the conditions of actual installation and use vary very widely in accordance with climatic conditions, etc.

The Committee also recognizes the fact that for overhead wires tests of insulation resistance are of small value in finding the probable injury which may occur to the insulation of overhead wires by disturbances or inductional discharges from the wires set up during thunderstorms.

It is thought that on account of the distance apart and varied interests of the several members of the Committee, that combined work by them will be, as it has been, out of the question if the Committee be continued, and that the efforts of the Committee will be rather in the collection of data, than in its production. It would, therefore, urge upon the various members of the Assoeiation, having tried and used several kinds of wires for overhead work, or tried and used underground systems of conductors to communicate whatever experience they have accumulated, so that it may be put into form and the results compared for the benefit of the Association.

It is believed that more real progress in the work of the Committee would be obtained in that way than in any other, particularly as the effect of time on the insulation of wires exposed to various influences, could in such way alone be brought out.

Respectfully submitted,

ELIHU THOMSON.

The following paper upon the same subject by Prof. Thomson was read by Mr. Rice:

INSULATION AND INSTALLATION OF WIRES AND CONSTRUCTION OF PLANT.

I have been requested to present my views on the above subject, and having recklessly allowed myself, in spite of the many other demands upon my time, to accept the chairmanship of your committee on the same subject, I have felt it my duty to at least say enough to provoke a general discussion and interchange of views between others who may have given more special study to matters in hand. My endeavor therefore will not be to arbitrarily lay down any rules, but rather to point out directions in which information may be gained and improvements made.

The subject is certainly very extensive in its scope, and could not be dealt with except in a very superficial way in the time at our command, and meanwhile, I feel constrained to state that I make no claim to the possession of any of the qualifications which would be requisite for thorough work on the subject.

In the installation of an electric light or power plant, we first of all find that the conditions vary very widely. Its size, location, the distance covered, or length of

circuits, and the climatic effects met with, need to be considered.

Then again the nature of the plant itself, whether arc light, direct incandescent, alternating system with transformers or converters, etc., governs to a large extent the conditions of the installation of the wires and of the plant itself. We may of course find in a single station or installation, representations of these and other characters of plant, such as medium potential circuits for power transmission alone.

Three or four years ago we should have been required only to take into account simple cases of high potential for arc circuits and low potential direct currents for incandescent multiple arc circuits, but the range now covered may be considered to be from any potential above fifty volts up to several thousands, and any current strength from about one ampere up to several thousands of amperes.

In considering the proper insulation and installing of wires for conveying these potentials and currents we are required to still further extend our field of view, and divide them into aerial, or overhead wires or conductors; and underground systems, and each of these taken in connection with the conductors for indoor distribution to the lamps, motors or other energy users. We have thus outlined the field which should be covered in dealing with a subject such as we have before us—"Insulation and Installations of wires and Construction of Plant" would furnish as a subject material to fill a many paged volume and not by any means exhaust it. May such a work soon be forthcoming.

Concerning the relative merits of overhead conductors and underground conductors, it is pretty generally agreed that except for expense and the difficulties of insulation, and connections from the mains, the underground system would be preferable as avoiding unsightliness, and liability of interference either by leakage, induction or contacts with other overhead wires. How to preserve the insulation of lines conveying high potentials, which potentials can not be avoided if distance is to be covered, without conductors of such size as to have a prohibitive cost, is a vital question. It may well be conceded that when the potentials used are very low, say 100 or 200 volts, the difficulties of insulation are very slight as compared with those of the use of two or three thousand volts.

It is a notable fact that so far as concerns the placing of overhead wires, particularly the wires of telegraph, telephone and such systems, and in some cases of electric light wires an extreme disregard of system, or orderly direction for such wires, is the cause of much of the unsightly appearence presented by them and much of the liability to get out of order. The tendency also has been to use very light and easily broken wires for telephonic work, such as may at any time come down upon the necessarily stronger electric light wires, strength being synonymous with efficiency in these latter.

It is thought that there is need of some rules or enactments which shall render impossible the mazes of telegraph, telephone, private wires, fire alarm, live wires, dead wires and electric light wires, (which

for our purposes may be considered as very fine wires such as may be seen in many of our large cities.

Should the wires of all kinds be laid or hung in [illegible] tunnels having a definite direction and on changing that direction by definite angles, such as right angles, in accordance with a pre-arranged system, then that much of the defective law existing to the placing of overhead conductors could be eliminated. Add to this a requirement increasing the durability and security demanded for telephone and telegraph wires and their supports, and the dangers of leaks and ground would in large measure be removed.

Many trials have been made, and considerable progress has resulted therefrom, in the direction of securing an insulating covering for electric wires, such as may adapt them to the use of high potentials without leakage, and prevent contacts forming by abrasion with other wires. This appears to be one of the most difficult problems in electric engineering. The problem is not so much to find a first class insulating substance for wire covering, but to find combined therewith, or to combine therewith, the qualities of indefinite durability when exposed to the weather, and great toughness and power of resisting cutting or abrasion. For overhead work, not only is an excellent insulator capable of withstanding very high potentials without leakage or rupture required, but such property must be retained along with the mechanical properties of hardness and toughness, for indefinite periods. Besides, the cost must not be too great.

To what extent any specimen or quality of insulated wire, or insulating material for outdoor use, fulfills these

requirements is a matter which it is difficult indeed, to determine fully, particularly as a test for durability must necessarily require a long time to complete. Indeed it would seem that our best guide must be the experience gained in the use of different wires on a large scale, under different climatic conditions, and with extremes of heat and cold more or less great.

Aside from the insulation given to a wire by its covering considered purely as an insulator, most stress must be laid upon the requirement of resistance to mechanical friction or abrasion, as tending to give immunity from grounds by contact with other wires or tree branches, roofs cornices, etc.

Toughness and elasticity of the insulation are hence seen to be qualities of high importance.

Whether such mechanical tests as will represent the conditions of actual practice in the use of the wire in relation to abrasion and percussion, bending, etc., which may break through the coating of insulator, can be devised and applied to test wires is somewhat doubtful, though without doubt much information may be obtained in the pursuance of such an object.

The retention of the toughness and elasticity for a reasonable period is of course demanded, and it is this retention which in otherwise excellent coverings is often absent, the effect of exposure being to render the materials brittle and porous.

It has often been proposed to make tests of the insulation resistance of the coverings of certain lengths of any wire taken as samples representing an average for such wires, under potentials somewhat exceeding that existing under actual use or practice, and so to deter-

mine the insulating capabilities of different coverings. But it is my opinion that, while such tests are certainly useful and important, and, in the case of underground wires or cables indispensable; yet, for overhead work since most of the length of the wire is exposed to air only, which is a practically, perfect insulator, and since the chances of leakage from the lines, arises most from imperfectly insulating supports, and from accidental contacts with other wires or surfaces, additional tests would in any case be required to determine suitability of an insulator for overhead lines. In this connection it may be stated that during thunderstorms, overhead wires are subjected to violent inductional effects giving rise oftentimes, to the momentary charging of the lines with potentials very far in excess of the potentials of any dynamos, and capable of breaking through the wire covering where it may be near or touch a metal object or wet surface. This breaking through may give rise to a weak spot, which will be followed by the dynamo current itself, if of high potential, and if at the same time other conditions be favorable to a diversion of current.

When overhead wires or pole lines are required to pass through and between branches of trees, a condition not infrequent in many of our towns and cities, considerable difficulty may be found in preserving the insulation of the line, the covering of which is apt to be rubbed off by the tree branches swaying in a wind. Fastening insulators to the branches for support and attachment of the wires is an uncertain remedy, on account of the swaying of the tree taking place in different directions not transverse to the line of wire, so that the wire is—

strained, or detached from its support along with the insulator by the violence of the actions.

Many and ingenious are the devices which the over-zealous lineman makes use of to suddenly or gradually and mysteriously lop off the offending limb, when the case is exceptionally critical and permission for the amputation of the offending member cannot be obtained from the conservative citizen whose sidewalk supports the obstacle to linemen's ambitions. It is also customary to thicken the insulation of the wire at such places as are threatened by abrasion, by winding on it a wide band of tough and plastic adhesive tape, such as can now be found in the market. If neatly and thoroughly done the insulation of the wire may thus often be preserved under decidedly adverse conditions.

It must be admitted that the insulation of a high potential circuit can never be too good, and that, therefore, any measure which may tend to its improvement and preservation is a double advantage, for not only are the dangers of grounds and leaks lessened, but the power of the current to do useful work is assisted. A considerable leakage from a high potential circuit means, indeed, a loss of power or efficiency of the system. For instance, the loss of one-half an ampere of current at a potential of 1,500 volts would represent about one horse-power of current energy lost, costing more than a horse-power at the dynamo pulley to supply such a leak.

This latter consideration is of especial importance in dealing with lines feeding transformers with alternating currents at high potentials.

With one thousand volts in the primary circuit it is

readily seen that a badly constructed or leaky line might easily cause the loss of a considerable percentage of current, such as would reduce the economy of the system, more particularly when running under light loads, at which time it is desirable to secure and to keep up the best possible efficiency.

When wires or cables are to be laid underground their resistance to abrasion is of importance only when they require to be drawn into conduits, or sections of conduits; but when once placed intact, they are not necessarily further subject to mechanical injury as they are generally surrounded by protective casings or tubes.

The total exclusion of moisture, and the possession by the wire coverings of a high insulation resistance, are requisites of great importance in such work. The difficulties are with low potentials comparatively easy to provide against, but in the case of wires at high electric potentials or pressures, such as arc light or alternating current primary lines such difficulties are much exaggerated.

The least access of moisture, such as may occur by flaws in the insulation may result in the production of a bad ground; or, a slight leak due to some original defect, may so improve itself by the passage of current as to become a bad fault, or a complete connection to earth. It would seem best in all cases not to place reliance upon the integrity and perfection of but a single insulating coating or covering for the wire but to give to it say three coatings successfully applied and which are in a measure independent coverings, all of them impervious to moisture and good insulators. If com-

posed of different materials, the peculiar liabilities to defect of one such coating may possibly be compensated by other qualities in another coating, so that there may be small chance of superposed defects in all coatings alike.

Let but the insulating capacity of each layer or coating be amply good to withstand the potential used, and it is difficult to conceive how trouble could arise from leaks due to defective portions of the covering. First cost is, however, a barrier to the perfection of underground systems, to save which cost, less effective and cheaper structures are often given the place which should be occupied by the more perfect and more costly.

It is important that, in cases in which overhead wires or wires above ground, are connected with underground lines, efficient means for carrying inductive discharges to earth be provided, such as is secured by the use of proper lightning arresters; for, faults may otherwise be produced in the best underground system of conductors due to static inductional discharges existing during thunderstorms at the moment of lightning discharges. These discharges are, in overhead lines, oftentimes quite vigorous and capable of puncturing moderate thicknesses of insulation. They are not to be confounded with actual passage of lightning strokes to the lines, which of course, have an infinitely greater capacity for mischief.

The preservation of the insulation of *inside* wiring is not difficult where the potentials used are low, nor is it difficult, with due exercise of care and skill in the running of the wires and the selection of suitable

courses for them to take, to install simple series lines, such as those for arc lights, which shall be practically exempt from leakage, unless abraded and brought into contact with conducting objects or moist surfaces involving leak to earth.

Unfortunately, owing to lack of skill and judgment and haste in installing, much of the wiring done is not as well done as it should be for the best results.

Distribution of current to groups of incandescent lights upon arc light or other high potential lines should always be undertaken with great care, and it is thought that such work should only be undertaken when exceptionally favorable conditions for avoiding accidental leakages exist, more especially should the potential of the line at the dynamo exceed 1500 volts or an amount which would sustain thirty arc lamps in series. One of the important elements of safety in such installations is simplicity and ease of inspection of the wiring, and no concealed wires should be used in them.

Concerning the wires which are suitable for indoor work, and particularly for high potentials, the endeavor has been to combine moisture-proof and fire-resisting, or rather incombustible, materials in the covering. The difficulty has been to find moisture-resisting substances which would not carry fire, and fire-resisting, or incombustible, material which would not carry or absorb moisture. The two properties seem in most cases incompatible. The tendency now is to surround the wire with a first covering of moisture-proof material of the nature of rubber, bitumen, resin, etc., and outside of this to place a second layer which will not carry fire.

For house to house and general incandescent lighting,

where the distances from the station are not too great, the direct low potential systems possess most of the advantages, the difficulties of leakage from defective insulation being of course at a minimum, but where the distances are so great as to make the required outlay for copper in the conductors, practically prohibit the extension of the system, a transformer or converter system, if of good design and economy, may be made to yield excellent results. In such cases the high potential primary wires need not enter the building, or when they do, may be suitably protected, the house or inside lines being of such low potentials as to be run with ordinary precautions as to leakage. However, the integrity of the system would be changed should a connection or leak form between the primary and secondary wires of the transformer, thus connecting the local or house line with the high potential outside mains. Such a connection might easily exist unsuspected, and would be a constant source of menace or possible danger, not discoverable by the mere tests for grounds as applied to the primary line at the station.

The expedient of securely grounding the secondary or local line was devised by me to overcome this difficulty. It ensures immunity from the risks arising out of possible leaks from the primary lines to the house lines, because such leaks are at once detected by the ordinary tests for grounds.

The consideration of the subject of what appliances are the best for the detection and location of leaks or faults in the insulation of conductors when they exist, and whether the ordinary crude methods are adapted to all cases of such detection, would prolong the present

paper much beyond its intended limits, and it will have served its object if it open up an opportunity or give occasion for a free discussion and interchange of experience and ideas upon the general subject forming its title.

THE PRESIDENT: The paper is now before you for discussion.

DR. MOSES: I have been informed that Prof. Thomson being absent, as the second on the list, the President requests that I shall speak to the resolution. I feel like quoting a passage that I think will reverberate in all your hearts: "The boy stood on the burning deck, whence all but he had fled." I do not see another member of that committee. (Laughter). When that committee was appointed, the President did me the honor to ask me to serve as the chairman, but for two very good reasons I declined. The first was—which he recognized when I declared it, and no doubt the convention did—that there were others more competent than myself to fill the place. Another reason was that I intended to return to Europe on some business that I had left uncompleted and I did not know how long my business would detain me. In fact I was right, because I have but just got back. Within the last three days I received a communication from the Chairman of the Committee asking me for my opinion of the report which has just been read—asking my approval or disapproval. I gave neither the one nor the other as the time was too short for him to receive my reply and I expected to answer him at the convention in person. As he is not here and has kindly submitted to the convention a paper which embodies

his own views on the subject, I believe that I should speak for the committee since they appear derelict on their duty. It must be borne in mind that a committee of solid men was appointed before this one was formed who did some preparatory work, but who declined to proceed further in the investigation without some money being put in their hands for experiments. But the President of our Association, with his usual intuition, appointed a committee composed of men that had laboratories at their command. If my memory serves me that committee consisted of Prof. Thomson —we all know how admirably fitted up his laboratory is; of Prof. Duncan, of Johns Hopkins University—we know how much care and time Prof. Rowland and himself have spent on that laboratory; Mr. Hamilton, of the Western Union, who has entire charge of the electrical outfit of the Western Union Company; Mr. Lockwood, of the Bell Telephone Company, known to you all by his writings and his active investigations in the direction of telephony; Dr. Waldo, who has had several university laboratories under his command, and Mr. Shallenberger, of the Westinghouse Electric Lighting Company. All of these gentlemen, as you know, are fully equipped, and to them he added me as a kind of tail to the kite, I suppose, out of compliment. However, I gave my reason and he accepted it and put me as second on the committee—perhaps because I had refused the chairmanship. But I did not intend to take any of the work out of the hands of those gentlemen, because I knew that all the different branches of installation would be properly represented by them. There was the telephone insulation, telegraphic insula-

[illegible] insulation — general [illegible] of the subject, so that the committee was formed for the purpose of getting an [illegible] report. Now, the reasons that have been advanced by the Chairman of the Committee are very valid in some respects, but as I only received a communication but two days before the meeting of the Committee asking my opinion on the subject, I am led to believe, though I have no absolute reason for saying so, that other members of the committee may be in exactly the same position as myself. They may not have received sufficient notice to enable them to give the report that attention it deserves. I do not feel as if that committee should be discharged. They are all good men and true. I am speaking for the others. I know myself to be such, whether I am good in that direction might be found out. I would suggest that the Chair should be invited to reappoint them and to make any one of them the spokesman—not so much for furnishing a report, as is usually the case with chairmen of committees, but simply to be a head. There must be a beginning. We cannot make round-robins in committees, but every member of that committee is able to do good work, and I think that the Convention would be very much benefited by getting their experience, and I hope that the next report of this Convention, which will no doubt be brought out in excellent style by the Secretary, supplemented by the cash assistance that we received today, which will enable us to publish a fine report, will be furnished with a report on insulation that will be of benefit to this Convention and that will be something of an honor

to American electricians for its thoroughness and fullness, and I hope that it may be a type for future reports that may be submitted to this Convention.

MR. DE CAMP: I agree with Dr. Moses in thinking that that committee should be continued. There is a great deal in it for discussion and which should be brought out in the course of some paper which could be presented to the Association before the close of this meeting which the members of this committee will have the benefit of, I suppose, when the reports of the Association are published. There is a great deal in that report which will come under the head of our underground discussions as well as the report on our overhead lines. I will therefore move at the close of this discussion, if there is to be any on this particular report, that the committee be continued as it is, to report at the next meeting of the Association.

The motion was seconded by Mr. Lynch and carried.

MR. LEGGETT: I wish to make simply a suggestion which occurred to me as this paper was read. It is doubtles a suggestion which has arisen in the minds of members of this committee, but it is barely possible that it may not have. That is the effect upon a lead covered cable of a short kink in the cable or of a dent in the lead—the compression of the insulation whereby the insulation is rendered a better conductor, and so at that point there is a better opportunity for the current to leak out. I suppose that has occurred again and again to members of the committee. In the matter of insulation it seems to me that would be a good point to consider. The same of course should be considered in respect to other insulations besides the lead covering.

There is one other point that occurred to my mind in the reading of the report that possibly might properly come under the consideration of some other paper. I notice Prof. Thomson refers to the high potential of the alternating current, and the point is whether that matter has been considered as to whether it is as high a potential as is reckoned—as one thousand volts, whether or not the potential, instead of being one thousand volts is not five hundred volts—I do not refer to the potential, I refer more particularly to the action of the insulation—whether or not the conductivity of the insulation is not required to carry a current of five hundred volts rather than one thousand—whether it is not an average between no current and full current, and whether that does not account for the fact, which I understand to be a fact, that with the Westinghouse alternating current they have put underground a number of their lead-covered conductors with good results—whether the result is not due to the fact that there is less required of the insulation.

Mr. Rice: If I am allowed to answer Dr. Leggett on that point I would say it is just about the other way. The potential that the insulator has to stand on a thousand-volt alternating circuit is two thousand volts, just about double what it would be on a direct current. That is occasioned by the wave going up for two thousand volts and then going down to zero. When you say one thousand volts it means an average of one thousand volts, but for a certain period of time that has to go to two thousand volts; it makes an average of one thousand. Perhaps the reason we do not have any more current with the alternating current than the

direct is that there is no active kick to speak of on a disruption of the line; whereas with a direct current there is quite a kick.

MR. LEGGETT: Will you allow me to speak of a personal matter for an instant? This gentleman addressed me as Dr. Leggett and I have been addressed so by nearly every member of this convention at times. Now, the title is all right; I would be very glad to carry it; but I have a brother, a Dr. Leggett, who is quite eminent in his profession as a patent attorney, and I am afraid I am stealing his thunder.

MR. RICE: I would say that I am often addressed as professor, but I remain mister.

THE PRESIDENT: *Doctor* Moses. (Laughter.)

DR. MOSES: *Mister* President. (Laughter.) I am glad that Mr. Rice has spoken on the question of the excess of potential above the general average, and also that Mr. Leggett has called attention to the fact. It is a mere hypothesis that the potential rises to two thousand volts because in measuring those currents, Prof. Rice will bear me out that he has never seen indications with an alternating current of a thousand volts potential. It, therefore, simply becomes a hypothesis. Because the current goes to zero and rises from zero, it is supposed that the average must be one thousand, and that the extremes should be zero and one thousand. But there is no evidence of that fact whatever. It is a surmise and it would be a very important thing for this Committee to bear that in mind, and the Secretary in making notes of these things would oblige us by sending to the Chairman of the Committee these points, so that they may be worked up. They are very important

to be known. I myself am pleased to hear that suggestion of Mr. Leggett that the condensation of a lead covered cable may act somewhat in the light of points in static discharge—

Mr. Leggett: My point on that went a little further—the compression of the insulation itself. For instance carbon chips will form a very excellent resistance for the passage of the electric current, yet if you compress those carbon chips they become a good conductor. The question is whether the compression of the insulation by the kink in the wire or by the bend in the wire does not serve at that point to make the insulation a better conductor.

Dr. Moses: I would say that perhaps the compression at that point will be extended as a pressure in the liquid, because these insulating materials are extended uniformly throughout a considerable area or mass in the neighborhood of the compressed point; so that the pressure would be distributed very evenly there. In the telephone, for instance, when the carbon button is compressed, is it not possible that the compression extends throughout the whole mass, and the multiplicity of points brought into varying contact produces the effect we seek; so that the compression may, as I say, be extended through the whole mass. I think since there is an induction taking place at each reversal of the current, that the point of pressure might be the one most dangerous, and the one which should be very carefully looked after.

Mr. DeCamp: I cannot claim any practical or theoretical knowledge as to this alternating current. I will simply put myself in the position of an asker of

questions. I have generally understood that one of the difficulties in maintaining perfect insulation with direct currents is not in the obtaining of insulation to cover a given number of volts, if they are constant, but to provide against what I understand is a reactionary current arising from various causes. Dr. Moses states, and therein agrees with Prof. Rice, that the alternating current runs from zero to two thousand volts. I am also—

THE PRESIDENT: Mr. Rice stated that the current ran from zero to two thousand volts, but Dr. Moses stated that was a hypothesis, and that there was no proof of it.

MR. DECAMP: There was no proof of it. Well, it is a case of "not proven"; but, do we stand convicted until it is proven?

MR. RICE: The burden of proof will have to be on Dr. Moses.

DR. MOSES: We stand as to that, as Faraday says we always should stand in the face of an hypothesis—with a suspended judgment. (Applause.)

MR. DECAMP: It has been demonstrated to every manager of electric light that grounds, either slight, intermittent or constant, are pretty sure to be developed by any reactionary current which is, incidentally or intentionally, created on that circuit. I think that that is correct. That of course is not only liable, but certain to create the particular ground, but it is likely to create others. It just occurred to me that if this alternating current is of that nature, that it is a constantly reactionary current,—continually so—and hence my conclusion would be that the difficulty of insulating against that

kind of current would be greater than that of insulating against a constant current.

THE PRESIDENT: Will you permit me to interrupt you a moment? A paper has been prepared by Mr. Shallenberger, entitled "The Energy of Alternating Currents." This paper will be read to-morrow; and this discussion will perhaps then be more appropriate than it is now.

DR. MOSES: Then I have nothing further to say at present.

MR. EUSTIS: With regard to underground wires I wish to mention a little result that came to my notice some time since which may be of some use to the Convension. In Prof. Thomson's paper he states that after the cables are once laid, they are not then liable to mechanical injury, owing to the mechanical covering outside. But I know of one particular case in which the insulating wires were laid in a wooden conduit, underneath a railroad track. The conduit was about six inches square inside measurement and three or four wires were laid in there loosely. Every time it rained the water from the side of the tracks washed more or less through the conduit, and carried with it, I presume, some sand. At all events, after the wires had been laid there about two years the insulation was found to be destroyed; and on drawing the cables out it was found to be due almost entirely, as far as outside appearance went, to purely mechanical injury. The only explanation I can see for that was the fact that as the heavy trains went over this conduit they compressed the ground, and the cables being laid as it were suspended—owing to its own stiffness, it being a No.

2 Brown & Sharpe wire, the two wires slipped by each other, and the gradual chafing of those two wires, one upon the other, was what cut the insulation through. If any one has had a similar experience I think it would be a benefit to the Association if he would state it.

DR. MOSES: I would like to ask if those wires were suspended.

MR. EUSTIS: They were simply laid loose.

DR. MOSES: Not even holding their own weight?

MR. EUSTIS: They were simply drawn into this box loosely; and they were undoubtedly full of kinks at the time. My idea is that as the box gave from the weight of the trains, the wires being loose in the box, because of their own stiffness, would spring by one another, the two wires bending differently.

DR. MOSES: I would like to mention, in connection with that, some curious facts that came to my attention yesterday, and which were told to me while several members of the committee were being hospitably entertained by the gentlemen here. We were visiting the Westinghouse works, and saw a very large trip hammer; and when we were up in the cozy office we could hear that rebounding and shaking the foundations with a force that was quite terrific. One of the gentlemen cited a fact, and a very interesting one it is, to show how, under repeated blows, material may be projected through a mass of other material. These slight vibrations might very easily cause the abrasion of the outer covering of two wires; for, when the trip hammer falls upon an anvil, if an iron scale gets between that and the anvil, the iron scale can be forced through the body of the anvil and come out at the

lower side; as is said to be the experience of many iron workers in Pittsburgh. It is a very interesting fact. I knew that if a ball of iron be put upon a solid barrel of rosin it will, after a while, be found at the bottom—its weight acting upon the viscous mass, causing it gradually to descend through it. And, as for instance, the impression of certain strong intellects may be felt over very large bodies of men, by persistent action—as I know occurred in one very particular case that I will not cite. But that is a very interesting fact. It also recalls to my mind a fact which I had the pleasure of stating at the last meeting of the Association—that among the cables of the Brooklyn bridge there are some hard-drawn wires that are always being thought of by the constructors of that bridge, because they are afraid that with the gradual stretching of the cable those hard-drawn wires will be less effective than the softer ones, and ultimately so great a strain will come upon them that they will be ruptured. So that a very small action, long continued, may produce just the results that he speaks of.

Mr. Eustis: With regard to the matter of the scale going through the anvil, I will say that in this particular case the abrasion takes place for lengths of about six inches, or twelve inches, at different places throughout the whole length of the wire, and extending a distance of something like fifty feet. There would be places eight inches in length, where the outside covering was completely chafed through, evidently from some change of that kind. What it is caused by we do not know. In other places the insulation was perfectly intact.

Mr. Brooks: The results of this slight jar or con-

cussion can only be seen after a time. This matter was brought to my notice the other day by the Pennsylvania Railroad Company. They had laid three cables in a wooden box on their elevated road. The boxes are perhaps four inches square, and are securely closed. It was found after a while that the cables began to give way. They opened the boxes and they found that where they were laid on the bottom board of the box the cables had worked, by reason of this jar about half way through the board; and it had taken the covering off, greatly to their surprise, so that the insulation was laid bare. I have seen that and heard of it in London, where they run the pipes on the overhead ways, even on those made of bricks or of solid masonry, this continued jar will in time begin to affect them. So that it is well, when anything of that kind is laid, to have it away from anything like concussion, although the concussion may be but small in amount.

MR. SPERRY: Inasmuch as Mr. Sunny, who has had a large experience in handling high potential direct currents underground is with us to-day, and as this matter of insulation is a very important matter, and anybody who can give us light upon it should be heard, I suggest that Mr. Sunny give us the benefit of his experience.

MR. SUNNY: My connection with the electric light business has only been for a short period; and I do not know that I am well enough acquainted with it to speak on the subject. We have had some experience with underground cables; and I have made some memoranda indicating the results of our experience which I intend to present when the discussion of underground cables

comes up, as I understand it will in a day or two. I would like to state, however, in reply to Mr. Leggett's question as to the effect of a dent in a lead cable, what the effects are upon insulation. We have to-day a large number of burn-outs in our lead covered cables; and I have been investigating a few of them, and I find as a rule that the cable has burned out at a point where the surface was perfectly true, and where there were no indications of mechanical injury. On the other hand, in pulling out cables, which have been destroyed, we have found portions of them where the mechanical injuries have been go great as to completely clean the lead off of the insulation, leaving the insulation bared. There was no indication, at the point where the lead was bared off, that any leak of the current occurred at that point. The facts that I have embodied in this short report are at the service of the Convention.

MR. LEGGETT: I would like to inquire, in those cases where a leak occurs, whether that leak is apt to occur at a point where the wire crosses above, or in the vicinity of steam pipes, or any other hot pipes,— one which would be caused simply by a difference in the expansion of the copper and lead, whereby one wire would be caused to force itself against the other, or compress the insulation between itself and the other.

THE PRESIDENT: If the gentleman will excuse me for interrupting him I will say that a paper on the underground system will be presented by Mr. Leggett, and another, as I understand, by Mr. Smith; and this discussion will more properly come up after the presentation of these papers.

MR. LEGGETT: That paper will be read by my brother.

THE PRESIDENT: One paper will be presented by Mr. Leggett of Detroit, and another by Mr. Smith; and this discussion will come very properly then. You will excuse me for interrupting you, and suggesting a postponement of this discussion, because the discussion would last a year to carry it through. I declare the discussion on this paper ended; and the next paper to be read is one written by Mr. Lange. As he is not here I will ask Mr. Martin to read the paper of Mr. Lange.

HOW CAN WE PROTECT OUR WATCHES AGAINST THE INFLUENCE OF MAGNETISM.

I have been invited to deliver to this convention an address on the influence of electric currents upon small magnetic matter. I can comply with this request in no better way, perhaps, than to devote myself especially to the discussion of this subtle influence as applied in particular to the delicate mechanism of our watches. Every man among us has doubtless been often impressed with the idea that absolute accuracy is the most desirable quality a time-piece can possess; that reliability is most essential to render efficient a guide so frequently consulted as the watch. You will, therefore, acknowledge the real importance of the question as to how we can best protect our time-pieces from the influences of a magnetism that must render them inaccurate and unreliable. Since the introduction of powerful dynamos has taken place, in large electrical establishments, and in many buildings supplied with independent and separate lighting plants, it has become evident that the

watches carried by persons coming in proximity to the dynamo. Whether such persons be constantly employed near the dynamo or only visitors to the works, it matters not, are very likely to become magnetized. Once under the influence of magnetism, the time-pieces must very soon show the effects of it, by either losing or gaining time, or stopping altogether: and the cause thereof is such, from its very nature, as would be liable to puzzle even an expert watch maker to remove. The advent of electricity in its modern and manifold branches of utility has forced upon us the importance of this question: How can we prevent this magnetism from gaining a damaging influence upon our watches? or, if not prevented, how can we best and most speedily repair the damage done?

Let us not look upon this question lightly, but rather in all earnestness. Let us bear in mind that, while the powerful dynamo in the engine room of the manufactory, the business house or the ocean steamship sends forth its currents through many lines to furnish light or power, it sends forth also a very different influence, and one that makes mischief with the watch carried by the engineer or electrician, the visitor to the works, or the captain or pilot, who may happen to approach for a moment within the influences of such a dynamo. Let us not forget that, in the latter event, serious results may follow, for, by the captain's chronometer, in conjunction with the compass, the great ship is sailed. We should bear in mind that, in the manufacture of our best watches, the object of the maker is to confirm in the smallest space possible the greatest strength and durability. In order to accomplish this object, he finds

it necessary to use, for the principal parts of the watch, hardened steel, a material decidedly susceptible to the influences of magnetism. The hair-spring and the balance-wheel—vital parts of the watch—are thus most frequently constructed; and, even though the balance be made of a combination of metals, the steel in the little points on the wheel may be attracted to the little steel screws necessary to perfect firmness in the larger mechanism of the watch; for these screws may be very readily charged with magnetism of sufficient force to be long retained and to exert a continual influence over other magnetic matter. The escapement-wheel—likewise of steel if durability be desired—becomes easily magnetized, also, and its movement is seriously retarded. Then the hair-spring, with its delicate coils close together, may be so polarized that the coils on the side next to the nearest steel screw will all adhere to each other, and play havoc with the motion of the watch.

Thus our very best time pieces are most susceptible to this influence which may, and often does, retard them to the extent of several hours in a day.

In my work as an investigator of this subject, which has extended over a period of several months. I have found three separate solutions of the problem: First, to have the watch made of material that cannot be magnetized; second, to enclose the works in an iron case, so as to shield the vital parts of the watch; and third, to apply efficient means to demagnetize the watch that has not been favored with the safeguards.

With regard to the first solution, I have had occasion to experimentally test its efficiency. I have applied the most complete magnetic tests to watches made by a

well-known watch company, which was claimed to be perfectly free from all magnetic influences. The hair spring and balance-wheel of these watches are made of paladium. I have no hesitation in saying, after subjecting these watches for three months to the strongest magnetic influences in the Westinghouse Electric Works, that their claim to recognition as non-magnetic timepieces is fully sustained. I have had one of these watches, perfectly timed to run with another, and subjected the two to opposite extremes as regards magnetism, yet discovered no deviation in their time keeping. The one was wholly free from the possibility of magnetic influence; the other was running at a point between the pole pieces of a most powerful magnet. I have watched both of them closely for weeks, without being able to detect any difference in their time.

Taking the hair-spring and balance-wheel from such a watch, I have placed them upon a little cork float in water, and then approached them with a most powerful magnet, without being able to detect the slightest motion of the little float or its burden; whereas the ordinary steel hair-spring and balance-wheel subjected to a similar test were so strongly attracted that they not only moved the cork float, but jumped from it to the magnet instantly.

While it is true that the screws and a large portion of the other mechanism in these watches is made of steel, yet all the delicate movements in the works are so entirely non-magnetic that, although the steel parts should be charged with magnetism to the highest degree, there would be no perceptible effect exerted upon the running of the watch.

Concerning the second solution of the problem—that is shielding a steel watch against magnetic influences by enclosing it in an iron case—I would say that I have not personally experimented with them; but acquaintances of mine entirely competent to do so, have given me an excellent idea as to what such watches are capable of. Watches in such cases have been very successful in resisting the ordinary influences of the dynamo rooms. But I would not advise that they be exposed to the influences of very strong fields—because in that case they would be magnetized and lose time.

Now for the third solution of the problem: Since it is true that comparatively few non-magnetic watches are in use, and that there are a great many of the ordinary watches with steel works, the question comes up naturally: How can we best demagnetize the watches if they have become injuriously magnetized?

An old way of doing this was in placing the magnetized time piece in close proximity to a dynamo, then revolving the watch rapidly by means of some mechanism and slowly removing it from the magnetic influence. This is a very unreliable cure at best, and in many instances, quite ineffective. A much better method has presented itself to me. I had occasion recently while constructing instruments for the alternating current, to observe some facts in connection with this kind of current and its peculiarities, which were suggested to me as being entirely available for use in a process of demagnetizing watches. In sending an alternating current through a solenoid and inserting in the solenoid a hardened steel core, I found that by

breaking the circuit, there was quite a positive polai
shown in the core. But, on the other hand, by insert
the core and then removing it slowly from the solenc
without breaking the circuit in the latter, I found t
the steel core had lost its magnetism entirely. Magn
izing the core as strongly as I might before t
operation, it would be, as I discovered, entir
demagnetized after submission to the process describ
Then I found the same proposition to be equally true
applied to a whole handful of steel particles. Tl
might adhere to each other ever so strongly before
operation; but if I endeavored to pick one of them
of the solenoid with the circuit undisturbed, the st
particle would come out entirely alone, wholly
magnatized, and free from attraction to the othe
Then I tried a watch whose steel pieces w
thoroughly charged with magnetism, and I fou
that the same process exerted the same eff
upon the watch as upon the steel core or upon
many particles of adhering steel. It was utte
demagnetized in all its parts, perfectly cured of
magnetic ailment. It would be unsafe to bring suc
perfectly-restored watch again within the influence
magnetism, unless the owner should be again desir
of resorting to the still reliable process described. T
solenoid need not be described to electricians. It i
very simple contrivance, filled almost to the top w
soft iron wire, leaving just room enough at the top
designed for the purpose described, to allow the ins
tion and removal of the watch in the manner not
Any person can apply the test successfully, and, if it
in a jeweller's store, or any other place lighted

incandescent lamps supplied from alternating current, the person need only remove the lamp from its socket, insert an attachment plug in its stead, connecting the current with such a solenoid, dip the watch in the hollow end of the solenoid, and, after leaving it in there a while, remove it without disturbing the circuit. In this way a perfect cure for magnetized watches might be applied in any store, factory or other establishment having alternating incandescent lighting plant. In conclusion, I have only to say that the first solution of the problem described above, namely, that of getting perfectly non-magnetic watches, is the best and safest one for those whose time-pieces are liable to be subjected to magnetic influences. I may also add that the third method, or cure described, demonstrates the wonderful resources of the alternating system of electricity, which, though it may work damage like other systems, has yet within its own qualities a perfect curative power, which cannot be claimed for the continuous or direct current.

Dr. Moses: That is an exceedingly interesting and valuable paper, and one which I think will be highly appreciated by the representatives of several of the largest watch companies in the world, who are now present. It was at the last meeting of the Association, referred to as a very important matter; and we are glad to know that Mr. Lange has been able to give us a means of overcoming the difficulty which is at once so thorough, so simple and so ingenious. I had intended to call attention to a fact which he has dilated upon. I have not read his report but I know that he was quite competent to handle the subject. The other day I had oc-

casion to speak to a friend about an experiment that I had tried on the previous evening. I was in my bedroom, and took my watch off to place it upon the bureau, where there was a little compass belonging to one of my children, and I thought to myself that I would see whether the watch, which was said to be protected by a magnetic shield, would affect the magnet. Fortunately for the experiment as I approached the watch to one of the poles it was repelled, and thus absolutely proved that there was a permanent polarity somewhere in my watch. Had it been simply a mass of iron that acted upon the poles of the compass magnet it would have attracted it to either pole; but, after repelling the first pole I found it was repelled, which was proof to me of the magnetic polarity of some part of my watch. This watch of mine has given me a great deal of concern. It was presented to me on my 21st birthday, and I have carried it as a souvenir on account of its having made me miss several important engagements: and I would do anything in the world to demagnetize it. In 1881, while at the Paris Exposition, I mentioned it to Mr. Varley, and he very kindly took it to an Edison-dynamo, and twirled it around in a way to reverse the polarity, which is equivalent to alternating the current, until he got away some distance from it; but still he did not demagnetize the watch. I could not understand the reason of this, but explained it to myself in this way: That there was a certain amount of magnetism in my watch, every part of it being of steel, and that certain of these parts were lying parallel to the lines of force at a given time, and that they attracted the magnetism, and acted upon the hair spring

balance wheel. But to continue the statement of my experiment, I mentioned that to one of my intelligent friends in New York, and he said "show me that, because I believe that my watch is taken in the same way. It stopped suddenly last night, and this morning went on again." I thought it a very important matter that we should manage to get our time-pieces going regularly; and it is quite evident, because of the reasons advanced in the paper which has been read, that this should be so. So I said, "let us see what is the reason." Said he, "I opened the case, some time ago, to see what was the matter. I found that the watch had stopped, and in order to see what was in the watch to make it stop, I opened it with my pocket knife, and perhaps my knife was magnetic." Said I, "Let us try it." So we took a needle, and floated it on a cork on water,—that being a delicate compass needle with which to test for magnetism. He applied his pen knife to it, but it did not work at all. So I said: "Who made your knife?" He said: "Rogers." Said I, "I guess it is a pewter knife." "No," said he, "it is a steel knife." I looked at it, and sure enough there was Rogers' mark upon it. I thought that I would show him how the needle would whirl around if a magnet was made to approach it; and so I took out my knife, which I knew had been made magnetic by one of my children a short time before; and I brought that knife near the needle; but it did not budge. Said he: "I guess yours is a pewter knife." I said, "Not at all; it is a Rogers knife too." I thought to myself, how is this? I recollected that only the day before I had been between the poles of an alternating machine. I had not tripped over it, nor was I thrown

fifteen feet away, as a gentleman is reported as saying but I was merely in the neighborhood of it; and probably my knife had been demagnetized in that way. The observations made by Mr. Lange in his paper more and more impress upon me the absolutely essential character of alternating currents for all distribution of electricity where we have to depend for life or for the safety of property upon the compass needle. I think that that paper points to the abandonment of the continuous current distribution of electricity on board steamships. That is a very broad saying, but I think will be proven, or supported, by the facts that he has mentioned; and that as soon as the attention of the owners of steamship lines is called to it, they will investigate the matter and verify the statement by experiments, and that the result will be a change of the continous current machines into machines producing alternating currents. That is a most important thing and may be the means of saving many lives. I have had opportunity recently to see something of the carelessness of the officers and sailors on ship-board in respect to handling the electric light wires when they are being moved out of the way. They do not seem to know what they are, or what they are doing. They do not consider the action of the currents upon the magnets that are there, or that the captain, in his walks up and down the decks, is relying upon those magnets for the direction of the ship. So that it is a most important thing that we should get rid of the possibility of reversal of the polarity. I think that the paper which has been read will prove one of the most instructive to be found in our annual proceedings.

MR. SMITH: I would like to ask Dr. Moses what would be the effect upon the ship of demagnetizing the compass. What mischief would it do?

DR. MOSES: The result would be that the ship would float around indefinitely; they would find the needle following the movement of the ship, and going around as any needle would if you blew upon it. If, for instance, you attempt to float a needle upon water, and come close to it, you will find it darting off like bacteria, in all directions. It takes so little to disturb it when floating on water that so slight a cause as the breath, or the jar of a closing door, will move it.

MR. KERR: I might mention the fact that there are about eight needles in a large ship's compass, and it would be hard to demagnetize them all at once.

MR. LAW: I quite agree with Dr. Moses in his experiments so far as he has gone, and I may state that I have been considerably troubled with my watch. It has a shield on it; but I will guarantee that if placed side by side with any watch in the room it will interfere with that watch's movement. I mean, any watch not properly protected. I have had considerable experience since the time of the Electrical Exhibition in Philadelphia. While there I had demagnetized hundreds of watches by the old process of spinning them between the poles of a dynamo. But be very careful, gentlemen, in doing that not to do it as a man did who came into the station one night, and said, "I would like to demagnetize my watch" and he held it out to the dynamo—and soon after he had to pick it up all round the room. I went through with a process of experiments last week with Prof. Houston; and I wish to

call the remarks which he made to the attentio
those who are investigating this subject. I will
state them in detail, but they referred to the
experiment of turning a copper disc between the p
of an electro-magnet. That copper disc will produ
current, and is called, I believe, Barlow's wheel.
supposition was that although the balance wheel of
watch was made absolutely non-magnetic, still if pl
between the poles of the dynamo its influence w
affect the balance wheel the same as it did
Barlow wheel. The first experiment was to p
the watch in the safe at the works for t
weeks. It was a watch manufactured by one
the largest watch making concerns in the cou
and was non-magnetic. The action was perfect.
was timed everyday by a reputable watchmaker. T
the watch was placed on the poles of a twenty l
Western machine and remained there for five minu
without any effect. My own watch was placed by
side of it, and instantly stopped. Then the watch
placed between the poles of a Arnoux-Hochhau
dynamo—a thirty light machine. The armature
taken out, and braced up by wooden blocks, so a
come right between the poles of the magnet,
directly in the strongest lines of force. We put
dynamo in series—lamp circuit, and the watch
placed in, and allowed to remain there one hour.
lost fifteen seconds during the time. But underst
gentlemen, that it was in a most powerful influenc
probably more powerful than it would ever be ca
upon to sustain in ordinary use. I wish to call
attention of those experimenting in that direction

a view of ascertaining if they have discovered any action on the balance wheel, even though it be non-magnetic, upon this old principle of Barlow's.

DR. MOSES: I would like to call attention to the first experiment ever tried and the one which led to the discovery upon which Faraday has built that immortal superstructure. Arago found that the needle of his compass, a short needle, oscillated too quickly. He had the compass altered for some purpose or other and a heavy brass plate put under the needle which diminished its oscillations about one-half in a given time, showing the influence of even a solid mass of metal upon it—the result being, as afterwards proven by Faraday, the induction of current in the copper dise under it which reacted upon the current circulating around the magnet; so that no mass of metal oscillating in a magnetic field will retain permanently the same number of oscillations per second that it had before it came into that field.

MR. GARRATT: I confess that Dr. Moses has somewhat frightened me; and I think that perhaps any one who has occasion to "go down to the sea in ships, and to do business in the great waters," might well feel alarmed if he were to assume that the great vessels, which are built of iron, which cross the ocean with their freight of thousands of lives and million of dollars worth of property, stood in any very great danger by reason of the electrical appliances which they now have. I know nothing whatever from personal experience about the effect of dynamo currents upon iron ships, and more especially the induced effects of currents upon instruments of navigation; but I am informed by a friend, an

engineer of experience, and in whom I have confide
that in some of the great ships, which are covered
a perfect ramification of wires, there has never
found any influence whatever upon the compasses
the electric plant which lights the ship, and does a
of the mechanical work upon it. In saying that, I do
in any way wish to reflect upon what Dr. Moses
in regard to the value of using alternating curr
where they can be so used on board ship, or in o
places where we must rely upon the magnetic nee
but it does not seem to me wise that it should go
from this convention that the present apparatus in
upon steamships is one of very great danger. On b
the Trenton the deviation curves of that ship
worked out almost every day for a time after the e
trical appliances were put on board; but no varia
was found in the compass needle, or of the magnetiza
of the ship itself, or of any part of it, so far as
engineers who very carefully investigated the ma
were able to discover resulting from the dynamo p
which the ship carried. I want to again say that I
not intend that statement as a criticism or reflection u
what we all must recognize to be the very valu
remarks made by Dr. Moses; only I want to sug
that we are not in any great danger, the next time
want to cross the Atlantic, of fetching up somewhere
Sandy Hook, after we have started for Liverp
simply because we have a dynamo on board the shi

MR. SPERRY: I would like to ask the last spe
if it is not a fact that those compasses are prov
with heavy masses of metal, thus forming a magn
shield around the compass?

MR. GARRATT: I should be most charmed to inform the gentleman, but he must remember that I put a saving clause in my remarks, and that was that I knew nothing whatever about the subject upon which I was speaking. (Laughter.)

THE PRESIDENT: In order to reply to Mr. Sperry's question, I will ask one of the secretaries, Mr. Colvin, who was an officer on board the Trenton, to state what the fact is?

MR. COLVIN: The compasses on a man-of-war are surrounded by a mass of metal which acts as a shield. In the case of the Trenton compasses—the case to which Mr. Garratt referred—I had occasion myself to work out those deviation curves, worked out on this side and also in the Mediterranean. We would swing ship and take the bearing of the sun on every point and every half point, sometimes with the dynamo going, and then with the dynamo not going; with certain lights in, and with certain lights out; with lights going in the pilot-house, and with lights not going in the pilot-house. We had a torpedo apparatus there, of which I had charge, and the currents of that did not affect the compass at all. The ship's compass is composed of a number of needles or bars of steel on the under side of the card; and I never knew any variation in those curves that would amount to anything. The captain of the ship does not walk about the ship not knowing what his compass is doing. He knows more about that compass than he does of his own mind; and it is worked out every morning; and every morning the captain takes a sight for the longitude, and by

that corrects any deviation of the compass; and so he is pretty safe.

Dr. Moses: This is a very interesting subject, if the Convention will excuse my bobbing up serenely so often about it; but I happened to be on board a French ship when there was a cross, and a fire started which alarmed all the passengers and officers; and although we were but a short distance from Havre, we all felt very nervous for about an hour. One of the wires was torn out on deck through the planks. Now, I would like to ask our friend, Lieutenant Colvin, whether, if a wire carrying the entire current from the dynamo that was competent to supply five hundred sixteen-candle Edison lamps were in that performance brought near to any one of the compasses upon which the captain depended, what would be the effect of that upon the compass—even though it might be surrounded by a very large mass of copper. Does he think that it would have no effect upon the deviation of the vessel from her course?

Mr. Colvin: In the case that he refers to the effect would have been that the quarter-master forward, and the quarter-master aft would notice that their compasses differed, and knowing that there was a difference the aft quarter-master would go forward and would steer by the forward compass.

Dr. Moses: I would like also to insert a saving clause. (Laughter.) I said that the entire crew captain, passengers and all, were in the highest state of excitement from the fire that was on board ship. We know some of the difficulties that would arise under those circumstances. Is it likely that there would be at

such a time any comparison of the accuracy of the compasses?

MR. COLVIN: On a properly run ship—I do not know how it is in the merchant service, for there they sometimes save a good deal of money by not employing competent persons, but in the naval service there are usually three persons looking at the compasses at once —the signal quarter-master and two assistant quarter-masters. As to your objection, I will state that in the vessels on which I have been, there has never been any wiring on the upper deck; it has been done with battens under the spar deck, and by the regulations of the department the standard compass is put so far from any vertical line, and so far from any horizontal line; and is usually some distance above the deck. That is the compass on which they rely. All the other compasses might be lost or broken, and there would still be no danger on a properly equipped ship that that particular compass would vary so materially as to produce any disastrous effects. I am speaking now of the naval service; I know that sometimes in the merchant service things are perhaps carelessly or ignorantly done. Your suggestion is a very valuable one—about alternating currents, and one which I will take pleasure in communicating to the Department, although I am not now connected with the service.

The President appointed as the committee, to nominate officers for the ensuing year, and to name the place for holding the next meeting of the Association, the following gentlemen: Eugene T. Lynch, E. R. Weeks, Frank Ridlon, H. D. Stanley and A. V. Garratt.

MR. DUNCAN: In view of our acceptance of the

invitation to attend the meeting of the Engineers' Society at 8 o'clock this evening, I move that we do now adjourn to 10 o'clock to-morrow morning. A further reason for now adjourning is that the Executive Committee has some business this afternoon, and the special committees will want to meet in the meantime, and if we attend that meeting of the Engineers' Society at 8 o'clock to night, which I hope every member will do in courtesy to them, we shall have done a pretty fair day's work.

The Association then adjourned to Wednesday, February 22nd, 1888, at 10 a.m.

PITTSBURGH, February 22nd, 1888.

The Association met pursuant to adjournment at 10 o'clock a.m.

THE PRESIDENT: The first thing in order this morning is the reading of the report of the Legal Committee, which will be read by Mr. Arthur Steuart, of Baltimore.

Mr. Steuart then read the following report:

REVISION OF THE PATENT LAW.

I have the honor to make the report of the Legal Committee upon the question of improvements in our Patent laws. The Legal Committee was constituted some years ago, and has been working along in an effort to arrive at some intelligent results on the question of improvements in our patent system. We all know

the intimate relation that exists between the electric lighting interests, and the patent system of this country; and how much the growth of the electrical interests is dependent upon the perfection of the patent system; and we all know from personal experience the serious effects and disadvantages that exist in the system as it is now administered.

Who can measure the benefits that this land has derived from the inventions that have been produced by its citizens? The roll of honor is too long to be repeated. The cotton gin, the printing press, the reaper, the application of steam to all the uses of civilization, and latest but not least, the modern application of electricity in its multitudinous forms; but while these brilliant achievements occupy our attention, we must not overlook the thousands upon thousands of inventions relating to matters of detail in every industry that have cheapened the product by saving time, material, power or labor. The fact is apparent that our advancement as a manufacturing nation has been due to the introduction of new methods of work which have enabled us to produce staples at such a price as to compete with other nations in the markets of the world, or in the development of new devices which have supplanted old ones or created a market for themselves. This being true, we must look for a cause for this development. What has induced the people of this country to create so many new things, to labor so long and ardently to lessen the cost of production of some article, or to supply a new one to take its place which is better or cheaper?

I think we may state it as a proposition that will not

meet with denial, that the prevailing motive of
American people is a motive of pecuniary gai
desire to amass wealth, to attain power by mean
money, and whatever avenue offers them this rew
will be the one into which they will press with a vi
and determination that knows no such thing as fail

When the framers of our Constitution inserted
it the clause which provides that "Congress shall h
power to promote the progress of science and
useful arts, by securing * * for limited times
* * * inventors the exclusive right to their * *
discoveries," they laid a foundation stone upon wh
an edifice has been constructed that has far surpas
anything they had conceived. Upon this provisio
the Constitution is our Patent Law based; from i
takes its spirit, and with the view of adhering m
closely to this spirit have the amendments to the Pat
Law been suggested, to which I shall ask your att
tion this evening.

The Patent Laws of the United States, passed
pursuance of this provision of the Constitution, o
up before every citizen of this country, as well
before those of many others, opportunities of obtai
wealth and power that are not presented by any o
set of circumstances under the sun. In a sin
moment of time, by a quick operation of the mind,
poor mechanic may be put into possession of an idea t
by its own development, may place him among
princes of the land. This is the possibility that
sents itself to every man, rich or poor, high or l
who comes to understand the meaning of our pa
system and its results. What force can be compa

with this, to produce in the minds of men, thought, deep, concentrated and continuous, for the production of inventions, a thirst for knowledge and a frugality of life that will supply a surplus of funds for the acquisition of knowledge and the development of inventions, and an ambition for their children that they shall have greater advantages of education upon which to work than their parents. And who can estimate the value to a State of such influence upon its citizens. This training, foreign manufacturers testify, produces in American operatives a power of comprehending their work, and a rapidity and dexterity of workmanship, that makes it impossible for them, with labor at one-half the cost and their factories fitted with the latest American machines, to produce the same goods as cheaply as they can be produced in this country.

It therefore goes without saying, that with such inestimable good to the nation, both in improving its industries and its people, to be attained by stimulating inventors to their highest effort, that the only true course for the law-makers to pursue in framing legislation relative to this subject, is to endeavor to make the process of obtaining a patent upon an invention as quick, easy and inexpensive as possible, and after it is granted to throw around it, in the hands of its owner, every form of protection known to the law, that will enable him to realize the full intent of the Constitution and enjoy the exclusive right to make, use and vend the invention.

Our patent system, as it exists to-day, is a grand structure, but it has some defects, which are due principally

to the fact, that the demands made upon it by the development of our industries have far exceeded anything that the framers of the present law contemplated.

The Patent Law of to-day is substantially identical with the law passed by Congress in 1836. This law was revised in 1870, and codified in 1874; but few changes were made in it, and little, if any, provision was made, to accommodate the immense mass of business that has been cast upon the Patent Office; and some of the new features that were introduced have been found to work a hardship upon inventors rather than a benefit; so that practically we are working under a law formulated fifty years ago, when the work of the Patent Office for the whole year was something less than it is to-day for each week. Is it surprising, therefore, that the child should have outgrown his clothes? And this is practically just what has taken place. A commissioner and a half-dozen examiners were quite equal to the task of examining intelligently four hundred and fifty patents a year; but the case is a very different one, when the Commissioner has under him something like two hundred examiners, and when the annual issue of the office is something over 25,000 patents.

If time permitted, I could show you how utterly impossible it is, for the work of the Patent Office to be accomplished, with any degree of satisfaction to the public, under the prevailing organization; but I know that most of you are quite as well aware as I am, of the defects that exist and are quite as much interested in removing them. I shall pass at once to the consideration of the measures of reform that seem desirable in the Patent Office.

I. THE PATENT OFFICE SHOULD HAVE THE EXCLUSIVE USE OF ITS BUILDING.

All those who have had any experience with the internal operations of the Patent Office are aware of the fact that this office is greatly cramped for space. The examiners are often crowded into rooms that are so small that there is scarcely space enough between the desks to move about. Many of the officers and employees are compelled to work in quarters that are unfit for human habitation, simply because there is no other place to put them; and the documents and records of the office are so crowded, and the places in which they are kept are so unfit for their accommodation that they are in contant danger of destruction. The Patent Office building was constructed with money, every dollar of which was paid to the Government by patentees and applicants for patents, and yet the Patent Office is crowded into less than half of this building. The Interior Department, with its Land Office and Indian Department, occupy the balance and are constantly encroaching.

The Interior Department should have separate quarters and the Patent Office should have the whole of the building which will not more than accommodate it.

II. THE PATENT OFFICE SHOULD HAVE THE WHOLE OF ITS OWN INCOME.

For the past fifty years, the Patent Office has paid all of its own expenses, has built its own building, and in addition to this, has paid the Government an annual

revenue, which aggregates to-day, without inte
something over three millions of dollars. And yet
most difficult task that the Commissioners of Pa
have had to perform, has been to induce Congres
authorize the expenditure of a part of this revenue
the necessary expenses of the Patent Office. For
proper dispatch of the work of the Patent Office,
siderable additional force is necessary.
Commissioner of Patents should be authorized
expend the whole of the income of the office for its
expenses, and what was not spent should be set
as a fund to be used for the benefit of the office at
time that it is needed.

III. EXAMINERS.

The staff of examiners in the Patent Office
charge of public interests of a most vital nature.
are the virtual judges of whether an inventor shall
a patent for his invention at all, and also of what
of a patent he shall have in case they give him any
It is therefore apparent that in order that they
perform their duties with intelligence and effici
they must fulfill several conditions.

1st. They must be thoroughly educated in the
nology of the arts and sciences, and in the Patent
Experience has shown that this training can onl
acquired in one or two ways,—either by syste
teaching or by years of experience in the practical
of the Patent Office; the latter method is the one
in operation and it results in creating a class of
aminers who are undergoing the process of educ
at the expense of the unfortunate inventor whose

may fall into their hands. The inventors of the country have a right to demand that this system of education of examiners at their expense be discontinued and a system adopted that will secure to the Patent Office a corps of examiners who will be thoroughly trained before they enter the office, and to the inventor the examination of his case by a man fully equipped to make such examination in the best manner.

2nd. Having obtained a staff of competent and thoroughly equipped examiners, they must be retained in office, so that the public may have the benefit of their services through a number of years. The Army and Navy have long since solved this problem by the exercise of a system of education, compensation, promotion and retirement on pay, which fully secures these ends. Why should not that system, so successful in one branch of the Government service, be established to secure similar and equally necessary results in the Patent Office?

3rd. The examiners should be relieved from all political influence. Civil service reform has attacked the question of political interference with Patent Office appointments with little success. The evils from this cause now existing are great and call loudly for remedy. The Army and Navy system put those departments of the public service almost entirely beyond the reach of the politicians. Thus it should be with the Patent Office.

IV. SALARY OF COMMISSIONER OF PATENTS.

The salary of the Commissioner of Patents should be very high, so that every examiner may feel that if he is

faithful and does his duty, he may some day, in the natural order of promotion, reach a place of honor and large emoluments. This is the system of the Army and Navy, and in those departments it works admirably.

V. A PATENT COURT SHOULD BE ESTABLISHED.

The greatest evil that exists to-day in the administration of the patent system, lies in the lack of harmony between the Patent Office and the Courts of the United States, in which infringement cases are determined. Every practitioner before the Patent Office knows how little regard is paid by the Exmianers to the decisions of the courts upon questions of Patent Law, and it has long since become a thing of the past, when the courts give any weight to the presumption of patentability, that would naturally arise from the fact of the Commissioner of Patents having granted a patent upon a device. For the accomplishment of the best results with our patent system, the interpretations and application of the law under which patents are granted should be the same as that under which rights growing out of patents are determined. So that a right granted by the Patent Office, would be sustained by the courts, and the rulings of the courts would be in conformity with the spirit of the Constitution which has originated the whole system.

Under the existing system the examiners in the Patent Office interpret the Patent Law for themselves; and it has been my experience that few of them agree upon many points. The practical questions, which have to be passed upon by the examiners, seldom, if

ever, get before the Circuit Courts, but are decided by the Commissioners of Patents. who it is well known, seldom possess any knowledge of Patent Law when they enter upon the duties of the office, and seldom occupy the position long enough, to be of any practical service to the office after they have learned something of the law by experience. The result is, that a majority of the cases passed upon by the eommissioners and which are intended for the guidance of the examiners, are decided at a time when the particular Commissioner is almost entirely ignorant of both the law and the practice of the office. It is, therefore, only to be expected that the examiners should form their own notions of the law and pay little regard to either Court or Commissioner, and as the examiners are not lawyers and have no knowledge of the Patent Law, except such as they may gain from the conflicting decisions of the ever changing commissioners ; and as they have had no judicial training, it follows as a matter of course that each primary examiner has his own interpretation of the law and his own peculiar notions of how it should be applied to the practical questions that arise in his daily work. The result is that we have as many different patent offices as we have divisions, and scarcely any two of them with the same views of the law, but each having the power, and exercising it, of issuing patents according to his own individual notion of what the patent should contain and how it should be framed, and these patents thus issued are the title papers upon which the inventors of the country are compelled to base their claim, when they come into the courts for the purpose of protecting their property. Is there any wonder that

it is difficult to obtain a patent of any value, or to sustain and protect it after it is procured? It seems, therefore, to be eminently desirable that the same tribunal (which shall be so framed as to insure its capacity) should have appellate jurisdiction from both the Patent Office and the Circuit Courts, so that by vesting both jurisdictions in one competent court, the rulings of both branches, the Patent Office and the Circuit Courts, may be made uniform and the anomaly removed that now exists of one branch of the Government employed in granting patents, and another, in destroying them; it may be said that such a Court exists at this time, but we all know how far removed the Supreme Court of the United States is from the Patent Office and how little influence it has upon its practice; besides which, the existing evils have grown up under the present system which demonstrates its incapacity to remedy them. A strong, well selected Court of expert patent lawyers, would have many advantages. It would harmonize the Patent Office and the Circuit Courts. It would crystallize the practice of the Patent Office, so that it would be possible for attorneys to form some conception of what that practice is and be able to advise their clients with safety with reference to their rights. The inventor could have some hope that when he had complied with his part of the government contract, by disclosing his secret, he would be protected in the exclusive right to use it. Such a court would lift a great burden from the shoulders of the Supreme Court, as but a small proportion of cases decided by it would be appealed to that court, and its rulings being binding upon the circuit

courts would enormously simplify the practice in those courts.

The jurisdiction of such a court should be altogether appellate and should consist in appeals from the Board of Examiners-in-Chief upon question of anticipation, patentability and practice, from the Examiners of Interference, upon questions of priority between applicants for patent upon the same invention, and of appeals from the circuit courts of the United States upon all questions relating to patents that now go to the Supreme Court. It would be proper also to include, within the jurisdiction of this court, all questious now passed upon by the Commissioner of Patents, such as trade-marks and labels; copy-rights might also be included. With such a court the duties of the Commissioner of Patents should be purely executive and the jurisdiction of the Supreme Court of the District of Columbia in matters of appeal from the Commissioner, should be cut off. The Supreme Court of the District, should bear the same relation to this court as the circuit courts.

Passing from the question of the reorganization of the Patent Office to specific amendments to the law, the first question that presents itself is the question of limitation to actions.

VI. LIMITATIONS.

It is pretty well settled by the courts that, since the adoption of the Revised Statutes 1874, there has been no limitation to the right of an owner of a patent to bring suit against an infringer for the recovery of damages for such infringement. Prior to that time, the

only limitation that existed was six years after the expiration of the patent—and this seems to be the just rule—many rules for limitation have been suggested, but it seems to me, in view of the fact which all of us have experienced, that the last few years of a patent are often the only ones during which the inventor realizes anything from his invention, that to cut him off from the recovery of damages from infringers, who may have pirated his invention during a period when he was too poor to stop them, would be unjust in the extreme.

VII. DAMAGES.

The existing equity rules, for the recovery of profits and damages for the infringement of a patent, are in very satisfactory shape; but since the decision of the Supreme Court in Root *vs.* the Railroad Company, these rules do not apply to actions brought for the recovery of damages after the expiration of the patent. Such suits must be brought at law, by an action of trespass on the case, and the measure of damages under that form of action are much less liberal than the rule in equity. In an action of trespass on the case, the measure of damages is the actual loss to the plaintiff and not the gain to the defendant; while in equity the rule allows the recovery of either, loss to the plaintiff or the gain of the infringer, whichever may be the greater, and often the difference is very great. If it is just and right that the owner of a patent should have all the benefits that may or can be derived from the use of his invention, and this is the theory of the law and in one form of action before the expiration of his patent is allowed to recover these benefits, in the

absence of a statute of limitations, why in justice should he be deprived of this benefit simply by the expiration of his patent? It would seem as if this evil should be remedied by legislation. It might be done by giving a plaintiff a standing in equity, under a bill for an account and discovery independent of an injunction; or if the patentee were permitted to bring an action of assumpsit, for recovery of the benefit that the infringer had derived by the use of his invention, this might be almost as well; but this would require the interposition of a jury, and in complicated patent cases it is difficult to accomplish satisfactory results with a jury. It is almost impossible to make a jury understand mechanical technicalities, or for the attorneys to do justice to the case upon oral testimony.

We have at this time a case in point which illustrates this rule. For seven years the owners of certain patents have been in constant litigation, seeking to sustain them. We have recently succeeded in getting a decree in their favor, and a month before this decree was rendered the patents expired. The patents have been extensively infringed and cover important inventions. We have now no remedy save to sue at law by an action of trespass on the case. As a matter of fact the owners of the patents have never established a license fee for their use, but if they had, as they might have done, it would not probably, have been more than $10, for each machine, hence this sum in our action at law would have been the limit of our possible recovery; notwithstanding the fact that the infringer by the use of each machine has saved to himself no less than $500. Why should the rule of law in a case like this be

different from that in a case where a man without my knowledge or against my will carries off my horse and uses him for his own benefit for a certain period, after which I recover him. In such a case, I bring a suit and the jury estimates the benefit that the wrong doer has derived from the use of my horse and award me this amount as damages for his wrongful act. Would it be right that this wrong doer should have the power of escaping liability, by answering when the jury found that he had made $100 by the use of my horse, that I could not in the same time have made but $10 with him? Would not this be putting a premium on the wrongful act?

The question is still an open one, whether in those states where the common law forms of action have been abolished, an action could be maintained at law for the infringement of a patent the substantial result of which would be the same as the common law action of assumpsit, although the statute prescribes an action of trespass on the case as the proper action.

VIII. REISSUES.

Since the decisions of the Supreme Court in Miller *vs.* The Bridgeport Brass Company and the line of cases that have confirmed this doctrine, it may be said that a reissue in the sense in which that term was formerly applied, is no longer possible. The unfortunate inventor who has employed in his ignorance, an incompetent solicitor to procure his patent, or who yields to the unnecessary limitations of the office, and whose patent is issued to him covering half of his invention, or possibly contains a disclaimer disclaiming the other half, can be

said to-day to have no remedy for his misfortune; and if two years have elapsed since he procured his patent, or some enterprising manufacturer examines his patent, and finding that he has not covered the second half of his invention, proceeds to make and sell that half, he is forever barred from going back and claiming it. Some change in the law should surely be made to enable an innocent and meritorious inventor to secure the full benefit of his invention, if this can be done without destroying vested property rights in individuals.

Under the present law, when a patent is surrendered in order to obtain a reissue, all accrued causes of action for past infringement upon the original patent go with it, and no action can be brought for an infringement committed prior to the date of the reissue. There does not appear to be any good reason for the existence of this rule.

At present an application for a reissue must be signed and sworn to by the inventor. This rule puts it into the power of a dishonest person to extract money from the owner of the patent by refusing to sign the reissue papers. The owner of a patent should have the power to deal with his property as he chooses, and as he is considered, when he purchased the patent, to have purchased all that could have been covered by the inventor's original application, if the patent does not do this, he should have the power to reissue his patent upon his own petition, and an oath that he is the sole owner, or if there be several, that they own the whole title.

IX. REPEAL OF PATENTS.

The statutes of the United States contain no provision which will permit a patent, supposed to have been obtained by fraud or mistake, to be set aside, nor for any action by the United States against the owner of such a patent to prove the fraud and have the patent declared void. The statute should contain such a provision.

X. EQUITY PROCEEDINGS FOR SLANDER TO PATENT.

Neither statute nor precedent in this country authorizes an equity proceeding for an injunction to restrain the continuance of slander against a machine or a patent, by one who falsely charges that the machine or the patent is an infringement of another patent owned by him, and threatens suit for such infringement, but neglects to bring such suit, and who thus continues to disturb the business of the party slandered, without attempting to execute his threats, or vindicate his claim. Such an injury cannot adequately be remedied by an action at law for damages; what is wanted is an injunction from a Court of Equity to stop the tongue of the slanderer at once and forever.

XI. LICENSES.

Licenses should be recorded and subject to the same rules as mortgages of land; the license first recorded should take precedence.

XII. JOINT OWNERS.

The mutual rights of joint owners of a patent are in a very unsettled state in the present condition of

the law, and it would, I think, be much safer to say that joint owners are entirely independent of one another, although there are some cases to the contrary, than to venture any statement with reference to what those mutual rights may be.

It would seem that no good reason could be advanced why joint owners of a patent should not bear the same relation to one another as joint owners of any other property. If two persons own a house jointly, but in definite proportions, and one of those persons rents the house and receives the rent for it, the other can of course receive his share of the rent, either from the person or from the property. The absence of well-settled rules upon this subject makes it very desirable that they should be established by statute.

XIII. UNITED STATES PATENT LIMITED BY FOREIGN PATENT.

United States patents should not be limited to expire with the shortest-lived foreign patent upon the same invention, for the simple reason that the American inventor who gives his invention as a free gift to the foreigner, gets a patent here for seventeen years, while he who seeks to protect himself abroad may limit his United States patent by several years.

XIV. ASSIGNMENTS.

Assignments of patents should stand upon the same footing as conveyances of land; the assignment first recorded should take precedence.

XV. EXPENSE OF LITIGATION.

Expense of the trial of patent cases might be lessen if the court was authorized, in impannelling a jury provided by the act of 1875, to impannel a jury of fi experts in the subject matter of the case, pay then suitable *per diem*, let them hear the testimony, a advise the Court.

XVI. INTERNATIONAL CONVENTION.

The United States, by its adherence to the Int national Convention, pledged itself to adopt legislat as soon as possible to harmonize the existing law this country with the international law. The practi result that Americans need in relation to foreign pate is a period of say six months, after they have secu an allowance of their United States patent, to m their applications abroad without affecting the term their United States patent.

I have thus presented to you some views w reference to the desirable changes and additions to existing patent laws, which we desire to secure; an have endeavored to show you the grounds upon wh those views are based.

I must also make a report of the work which committee have had in hand during the last six mont in attempting to bring about the results which are h outlined to some extent.

At the meeting in Boston, held last August, Association passed a resolution authorizing the Le Committee to introduce into Congress a bill provid for the creation of a commission, to be appointed

the President of the United States, whose duty it should be to revise the existing patent laws, and report a Bill to Congress at its next session providing for such changes as they thought desirable. In the preparation of that Bill, and in looking over the ground to see whether the course was a desirable one, I was met on all hands, and on every side, by the earnest opposition of the ablest and most careful lawyers in the country, those most interested in the patent system; and they came to me with this proposition: They said, "You are doing a good work; you are in a good line; but there is an evil that we cannot escape; there is an opposing force that we must consider, and that is a deep rooted opposition to the patent system as an element in our national policy that exists in some parts of this land. That opposition is represented upon the floor of Congress by a great many members; and any Bill of this kind, which is introduced opening the door wide to revision, may have the effect (and the danger is an imminent one) of giving opportunity to these enemies of the system to come in and do the system harm." As the result of that advice (and I found the sentiment which prompted it very general and prevailing) the committee determined to change its course of action and not to introduce that Bill, but to frame another. The question of what that other bill should contain has occupied the mind of the committee up to this time. It has not been fully determined, but it will be very shortly. For the purpose of arriving at a solution of that question, and determining what that Bill should contain; and for the purpose of interesting the members of the Association in the work, the Committee entered into personal

correspondence with every member of the Association and also with every person whom they could find who was directly engaged in the electrical business. I think that I do not draw it too strongly when I say that they have been corresponding with not less than one thousand people throughout this country, and we have by that means been able to gather a mass of valuable information. The committee published a pamphlet, 2,000 copies of which were distributed among the members of the Association, the members of Congress, and among others who were interested in the subject. They have more lately published another pamphlet, 1,000 copies of which have been distributed throughout the couutry, the purpose of which was to interest all whom we could reach in this subject, and get their minds into a condition so that when we were ready to present the Bill they would be prepared to respond to our call upon them for aid. I go from here to-night to Washington for the purpose of making arrangements in your behalf before the Committee of Patents in the House; and I have a memorandum here of several subjects which are now pending before the House Committee, which it is our purpose to oppose. For the purpose of looking after this question the Committee have been partially instrumental in organizing in the City of Washington a Bar Association among the patent attorneys there. That Association embraces the most important men in the profession in that City; and, being on the spot, we look with great confidence to their aid in opposing anything detrimental to the system, and in aiding us very materially in our efforts before Congress. When I presented the subject to them I

found that they were deeply interested in it, and anxious to join hand in hand with us in attempting to improve this system. The meeting whieh will be held tomorrow will be attended by a number of gentlemen whom I have notified, from different parts of the country; from Chicago, Boston, New York and Providence — all of whom will come to oppose the passage of certain bills which are now pending before the House. One of them is a Bill which provides that patents, not used in manufacturing, but held to control the trade, shall be vacated by due proceedings and at the instance of anybody who wants to use that invention. A second measure is an "innocent purchaser" Bill (which you are probably all familiar with) which protects a man who cannot be proved to be a fraudulent user. The third Bill, gives to the Circuit Courts of the United States the power, at the instance of a would-be user of a patent, to examine a patent, and determine what would be a reasonable royalty for that infringer, or would-be user, to pay for the use of the invention, and to grant to him the privilege of using it without any restraint on the part of the owner of the patent. A fourth bill reduces the grant of United States patents from 17 to 7 years. There are two other "innocent purchaser" bills, and two others which strike at the question which is now troubling telephone companies, and which may some day trouble you in your electric light business,—and that is the interference of State Legislatures with the right of the patentee to use his patent, or the right of the owner of a patent to control the use of that patent. In Indiana the Legislature has passed, as you are all probably aware, a law which limits the price which shall be paid

by its citizens for the use of the telephone. That law has resulted, in many cases, in the refusal on the part of the company to permit telephones to be used at all, except on their own terms. A bill has been introduced (in fact two of them) for the purpose of making it impossible for State Legislatures to bind the owners of patents by such legislation.

All of these are vital questions, and they lie at the very root of the patent system. If any of these bills becomes a law the system will receive a very serious blow; and it is our duty in your interest to oppose their passage. At the same time that this meeting of the Committee takes place to-morrow there will be a meeting for the purpose of opposing the passage of these bills, and there will be a number of gentlemen in Washington, many of whom represent electric light interests,—the Edison Company having promised to send their counsel, the Consolidated Companies will send theirs, and the Westinghouse Companies will send theirs; and we will have gentlemen from various parts of the country, all of whom are deeply interested in this question, and in the effort to reform our patent laws.

The President has just handed me a memorandum which says that there are bills, similar to the laws in effect in Indiana, now before the Legislature of our own State, which is now in session, limiting the charge for telephone service in Pennsylvania to the same rate as is fixed in Indiana, three dollars per month.

As I was saying, we will hold a convention in Washington tomorrow to discuss the question of exactly what is desirable, and in what essential par-

ticulars we shall move. We are all of us very well satisfied that our best chance of success lies in attempting very little—in narrowing our efforts down to one or two salient points, and concentrating our efforts upon those. The probability is that we will concentrate our efforts upon two points only: One will be an increase of the salary of the Commissioner of Patents to such a sum as will justify a man of sufficient capacity in holding the position long enough to be able to establish some practice in the Patent Office which would be satisfactory. The figures were given me the other day—I did not make the calculation, but gentlemen of eminence in Washington who have been familiar with the office for many years, have said to me that they made the calculation, and that the result is in finding that for fourteen years the average time of the Commissioner of Patents has been but fifteen months. When you consider that each one of those men has gone in there with comparatively no familiarity with either the laws or the practice of the office—with some few exceptions, for some of them have of course held office for a longer time and some for a shorter time—when you consider that each of those who have gone in there have gone in with but little familiarity with the subject, you can understand how perfectly chaotic must be the condition of the rulings and practice of the Patent Office. That will probably be one of the points upon which the committee will concentrate their efforts. A second will be, to establish an intermediate court of patents, which will hear appeals from the Circuit Courts, and also from the Patent Office. This is the work which the committee now have before them. (Applause.)

DR. MASON: So far as I have been able to learn the efforts and the discussion in previous sessions of this Association on this subject have been with the object of confining the work to be done exclusively to those who are interested in electrical matters. Am I right, Mr. President, in this supposition,—that the work and plan of the Convention, mainly if not entirely, has been confined to those who are interested in electrical matters?

MR. STEUART: Yes, that was the case until we organized the present Bar Association at Washington, which represents diversified interests.

DR. MASON: It strikes me that it would be well to reinforce ourselves by an effort to gain the sympathy and co-operation of the different societies of engineers in this country, who are, if not equally interested with the electrical associations, and with electrical gentlemen, at least have a profound interest in this same question, and who would probably be glad of an opportunity to work right along in the same line with us. I wish to throw this out as a suggestion; and then to make a remark which will be rather in the form of a question. It seemed to me that at one point of the paper read to us, it reflected upon the intelligence, or the culture at least, of the Examiners and assistant Examiners in the Patent Office. I would suggest that a thorough acquaintance with the history of the men who are now the Examiners and assistant Examiners in that office, would develop the fact that a large proportion, if not the majority of the Examiners and assistant Examiners either have been admitted to practice at the Bar, or have been graduated in schools of law. I wish to throw

this out as a suggestion, I think it would be well, in a paper issued by us, not to reflect upon either the intelligence or the culture of the Board of Examiners and assistant Examiners.

THE PRESIDENT: I do not see how you can present a paper in this Association without reflecting upon them. If there is nothing wrong, then there is nothing to right.

DR. MASON: We might reflect upon the system, but not upon these gentlemen.

THE PRESIDENT: Perhaps that is so; but I think that you will have to reflect upon both of them before you get through.

MR. LEGGETT: I dislike to rise in opposition to a measure of this character, but, from the very outset of this action on the part of this association, it has struck me as a piece of very bad wisdom—a thing which we ought in a very quiet way to abandon. Now, these questions, every one of them which were raised by Mr. Steuart in his article (a very excellent article) are questions which affect not electric light companies, but the manufacturers of electrical apparatus. There is scarcely a manufacturer in the country but what is willing and anxious perhaps to change certain features of the patent law; and yet I doubt very much, from the experience which I personally have had with manufacturing interests, that they desire the system to be attacked in a general way. We have a patent system which is by far the best of any system on the face of the earth. There is no question about that. Canada has followed it, and has made a patent law almost identical with ours.

England, which has had a patent system for one hundred and fifty years, and perhaps longer than that, has followed ours within the last three or four years, and has patterned almost word for word the principal sections of our Patent Law. Germany, advanced in all these matters of patent law, and in material interests of this character, has followed, within the last three or four years, with a new patent law based almost word for word upon ours. Belgium is seeking the same pattern to copy from. The result of the patent law of this country has been the development of industries of such great magnitude that it has been copied into the laws of all nations; for all nations are coming to adopt the same basis in this matter; and it therefore seems to me very bad policy at this period, when there is agitation against certain features of the patent law, to raise the issues which are now suggested. Many of you will recollect the action which was had a few years ago on what was termed "Bill 300;" and at that time, as some of you may recollect, a Bar Association was formed in the City of Washington with a view of dealing with this matter. It may have gone into a condition of "innocuous desuetude," but I think it was never formally disbanded. That Association, it is safe to say, together with its ramifications throughout the industries of this country, was able to collect and expend probably a hundred thousand dollars at that time in an effort to amend the patent laws. Every feature which is here raised was raised at that time, I think, without exception. The bill passed into the House and into the Senate, but there was no possibility of getting it through. Now, I know that there are certain features

which have crept into ouf patent system, and which frequently have been the subject of inquiry, and doubtless will continue to be among the difficulties of the system, and one of them is how to remedy suits against users. That is where the prejudice had arisen all over this country. On the drive-well patents thousands of suits were brought throughout the country; and in another litigation in which I was the attorney - the Birdsell-Clover Huller cases, we brought over a thousand suits in this country; and I had the pleasure of having the bees hum about my ears for years, in connection with those suits. It is folly to pursue the large manufacturing institutions to stop the infringements. The remedy seems to lie, in that respect, in a measure which would reach the corporations. It is a very simple thing for a manufacturer to go to patent counsel, or to proper authority, and have a search made which will determine absolutely whether the thing which he is about to make is going to infringe a patent. But, instead of doing that, the corporation takes up an invention, goes ahead and makes it, and puts the articles out all over the country and the users buy them innocently, while the real inventor is defrauded out of his rights by the fact that the whole market is taken possession of, and he cannot tackle these powerful corporations. That same matter has been corrected in many countries. In France, for instance, the infringer is punished by fine and imprisonment. First, by fine and forfeiture; and not only a forfeiture of the infringing articles themselves, but a forfeiture of the machinery and tools employed in making them, for the benefit of the patentee. A second offence is punished by fine and

imprisonment. In Germany, in Belgium, in Russia and in Sweden it is the same. In Spain the measures are still more stringent. In Italy, in addition to fine and imprisonment there is a clause to the effect that no action shall be delayed for more than one week. Laws of this character, making the infringement of a patent an offence punishable by fine and imprisonment, stops it at its inception. The manufacturer does not go into the business. He keeps out of it; and consequently suits against users are unknown, and the protection of property in patents is recognized and enforced. Now, in order to strengthen the law of this country in that respect, it is necessary simply to build up the wall around inventors, and not tear it down. But, this is a matter which affects the manufacturing interests, and not our Association interests solely. It seems to me, a matter in which a hundred thousand dollars was expended not later than 1877 and 1878 in a futile attempt to amend these special features of the Patent Law,—it seems to me in such a matter that it would be poor policy for this Association, where not one single interest is involved, to go ahead and expend the little money that we have on hand in seeking to carry out measures of this character. I do not believe it is good policy. I do not believe the movement reflects the sentiments of the different interests represented in this Association. I think that this matter was proposed to us and carried through without sufficient thought. We are launching upon an investigation here which has no end. What have we to do in the matter of promotions in the Patent Office? What have we to do with the question of the compensation of the Commissioner? These are

things which the patent attorneys in associations where large manufacturing interests come together, will reach a conclusion, and that conclusion will be satisfactory to all. I think, gentlemen, that when this discussion is about to end I will offer a suggestion, perhaps in the form of a motion, that this Association lay this matter upon the table, and expend no more moncy in it. I would like to hear other gentlemen express their views upon the subject if they have any.

MR. STEUART: If I may be permitted, I will make a remark in reply to the gentleman who has just spoken. His suggestion is that we are opening up a wide field in an apparent effort to tear down the walls of protection which surrounds the patentee. I am sorry if I have expressed myself so obscurely. I am sorry if I have not made my meaning clear in my effort to suggest that the whole purpose of this committee, the whole purpose of the effort which has been made, has been to build up around the patentee every safe-guard and every weapon of defense against infringers that could possibly be devised. That has been our purpose, solely and entirely. Our effort is to protect the patentee, to strengthen his patent right, and to give to the owner of a patent a right that will be far more valuable than any right which he now possesses—and particularly in relation to electrical matters. With reference to the gentleman's suggestion as to the advantages which our system has over other systems, I wish to say that I fully appreciate those advantages. We have the best system in the world; and those countries that have followed us, — Germany, England and Canada, (particularly Germany,

which has followed us most closely), have carried our system to the very point beyond us to which we seek now to carry it. The last thing done by the German government in perfecting their patent system has been to establish a court especially for patent appeals, and to put over their patent office a man who will hold his position during a term of years sufficiently long to enable him to understand the practice and to dictate proper rules to the examiners who are under him. That is what we seek. That is all that we are now seeking. It is simply to carry forward our system so as to complete it, and put it where our imitators have already gotten theirs. They have carried it beyond ours in theory. With reference to the effort which was made ten years ago to alter or amend the patent system, the gentleman has suggested that an effort was made in which a hundred thousand dollars was spent, and which was unsuccessful because, as he intimated, it was impossible to make any changes. I would like to read a clause from a letter which I have in my hand from Mr. James J. Storrow, whom we all know, of the Bell Telephone Company, on that subject. He says:

"Ten years ago an attack was made upon the patent system, as you know, by an organized company of infringers. The best that my associates and I, representing a large amount of patent property and interests, could accomplish was to agree to some modifications which we thought were wise, and would tend to remove some features of the law which we had to admit, however, were very obnoxious, and to agree in a modified form to some others that we thought would

be passed in a worse form if we did not come to an agreement about them."

The facts with regard to that effort were, that it was an effort by a band of infringers, who were determined to break down the patent system if they could, or to introduce features into it which would enable them to use certain patented property which they wanted to use, free of charge, and free of liability for infringement. A hundred thousand dollars was spent, but it was spent to a large degree, in defence of the patent system against the attack of the infringers. At present we propose, (although there are many suggestions made, those suggestions are made for the purpose of gaining light upon what is the most desirable thing to do), and have settled down to the conclusion, as I have suggested, that we will do just what Germany has done; we will put over our Patent Office, if it can be done, a man who is thoroughly capable of managing it; and we will establish an intermediate special court for patent appeals, with jurisdiction to hear the technical questions which now go into our courts where there is, in many cases, at least, an entire absence of technical knowledge. We are attempting to build around the patent system, and around the patentee, a wall which will be a benefit to every member of this Association. Indeed, I can hardly conceive how any association that has existed in this land could be more interested in this subject, or could more properly be said to be the right source whence efforts of this sort should spring, than this association.

Dr. Moses: Referring to the remarks of Mr. Steuart, I would like to mention an incident illus-

trating the efficiency of the superior court in Germany. A friend of mine who represents a very important patent abroad for electric motors, was recently laying that motor before various manufacturers in Germany, for the purpose of uniting with them in the exploiting of the invention. He met one of the largest manufacturers—who shall be nameless, although his action should be blazoned abroad so that we may know what some men are capable of doing when they have the power to do ill. This manufacturer said to him: "That is a very good invention indeed; but if I want it I will use it"—in those very words. My friend, thinking that the gentleman was, so to speak, on his own dunghill, and had the idea that perhaps he might do so, thought that he would investigate the question; and on doing so he found that this appellate court would not only protect him, but would take cognizance of such a remark. It is a bad spirti; it is a freebooting spirit, and ought to be repressed as much as possible. A patent represents a concrete idea, an accumulation of mental wealth, that a man is entitled to hold and to have just as if it were hard dollars. He spends hard dollars in exploiting it and in perfecting it, not to mention many sleepless nights. Now, if such a law as Mr. Steuart proposes can be brought forward, so that we could have such a court, there would be a greater dignity attached to our patent system. As it is, the American system, excellent in many respects, commands admiration abroad for the very thorough manner in which claims are investigated in the Patent Office. I have heard many compliments paid to it by distinguished patent lawyers. Another incident I would

call to mind as showing the necessity of having a comprehensive and logical system. It is well not to touch a crumbling structure for fear that you may precipitate ruin upon yourself; yet, at the same time, we put in all sorts of tie bolts, in order to keep it in position temporarily. Those tie bolts should be, in our system, an avoidance, if possible, of those extraneous matters which rather tend to weaken the confidence that the patentee has in the security of his right. A glaring instance came under my attention in England recently, where a very valuable patent taken out by an American in England, was received most favorably, and large amounts of capital were ready to exploit it, until it was found out that a publication, which for the life of me I could not see was a publication, (describing the American patent abroad without its being published to the world), that is, the mere act of issuing a patent threw such a cloud upon the title to the invention that it was impossible to exploit that particular apparatus. Now, those uncertainties should be removed if possible, if we have them, and they are such as Mr. Steuart referred to; such, for instance, as where the expiration of a patent abroad may limit the life of the American patent; such things as that should be investigated carefully, and if errors have crept in which cannot be corrected now, still in the future they might be; and it would be a very wise thing for us in some way, as a body, to call the attention of the Legislative branch of the Government to the fact that we are willing to cooperate with all other branches of inventors, or societies that represent inventors, in order to give a greater stability to the

patent laws and greater protection to inventors. That course, I think, is very admirably outlined by the committee who had it in charge; and I hope that we will give as much moral support as possible to those gentlemen in their very arduous, (but not a thankless task, because they will have the reward of our praise), and most useful effort; because it will tend to give greater security to the American inventions which are now, particularly in our branch, the fundamental ones at the bottom of the greatest industry that has ever been started,—and that is the electric light industry.

MR. PHELPS: I share with Mr. Steuart in his surprise that the work of this committee, or any action of the Association upon it, should be construed as being in anywise an attack upon patent protection, or the patent system. I suppose it is quite within the truth to say that the movement was conceived and started purely with the purpose of conserving all the protection that inventors now have, and of clearing up as much as possible the obscurities that exist in relation to inventors' rights, by better methods applied to certain portions of the system as now practiced. I think there can be no doubt about that. I was also a good deal surprised that any one should fail to see the very immediate and direct interest that all the members of this Association, as well as manufacturers, have in this question. It seems to me that the confusion which exists in respect to the relations of many patents to one another, and the rights of various people with respect to one another, is a source of constant anxiety to nearly every one engaged in the electric light business. I think that the work of this committee has been fully

justified, and the time spent upon it has been fully justified by the results that have been reached up to this time. If I understand our position now, we are expected to pass upon the suggestions made by the committee, for I suppose that the remarks of Mr. Steuart made after reading the report of the committee as presented in the printed pamphlet, are to be considered also as the report. The proposition, as I understand it, is, to entirely abandon the idea of the creation of a Commission, and instead of that to direct the energies of the Bar Association of Washington, supported by an expression of opinion as evidenced by a vote of this Association, towards the accomplishment of two distinct measures: The creation of an appellate court; and the increase of the salary of the Commissioner of Patents. Both of these measures seem to me to be quite free from the objections which would attach to any measure which visibly showed the object to be the increasing of protection to the patentees. I am very glad that the committee, and probably all the members of the Associations, or a large portion of them, have recognized the danger of introducing any measure which should seem obviously to be addressed to the increasing of the value of patent monopolies in a money sense; but these measures simply look to conserving the rights and the protection now afforded by our patent system, by a modification of the methods of administering patent laws. The measures suggested, as they seem to me, do not afford an opportunity for attacks upon our patent system; and it would be difficult to make amendments to either of those propositions which would attack the patent

system. Therefore I trust that the Association will see fit to endorse the proposition of the committee as I now understand it to be.

MR. LEGGETT: I think I may be misunderstood if it is inferred that I assume that the action of this committee is in the nature of an attack upon the patent system. I do not consider it an attack in any way, shape or manner. I think that the recommendations of the committee, in most respects, are good and that they will correct abuses in the particular channels indicated. The point with me is simply this: Is it policy for us as an Association to divert our funds (which are very limited, to say the least, although we now have a proposition before us to double our dues, in order to carry on our business properly) into another channel. If there are those in this Association who desire to further the ends suggested; if there be manufacturers with us who have those ends at heart, and if it is for their advantage that these recommendations be carried out, let them act personally and individually to advance the object which they desire; let them join this movement; let them divert their own funds into that channel; but, of what earthly use is it to an electric light company to interfere with these matters in the Patent Office? It seems to me that there is no interest in this country that has been so well served in the Patent Office as the electric interest. I do not think that a set of patents has ever been issued in any country that will compare with the electrical patents which have been issued in this country. Why, the Bell Telephone patent—a patent obtained from our Patent Office—has withstood attacks in all the courts of this

country; and even an action by the Government itself to annul it has failed to reach it. If we look at the foundation patents of the electric light companies we find that they also are very admirably drawu. All of these inventions relating to electric interests have been conserved in the Patent Office, right straight from the very beginning to the end. The point I make as to this matter is that, as an Association, we simply suspend our operations at this point, and recommend if necessary, or if thought desirable that the individual members of the Association be requested to lend their efforts; but that the Association funds remain intact for the use of the Association. If this thing is to go on you will need to spend thousands and perhaps tens of thousands of dollars before you will know where you stand. I recollect that at the time "Bill 300" was under consideration a party gave me sixty dollars a day for more than two months to remain in Washington and look after their interests in connection with that bill; and it was not very large compensation either. I know of attorneys in this country who were paid two or three hundred per day for four or six months—Mr. Starrow, for instance—who represented large interests at the time. While it is true that there was an attack by an organized band of infringers, still it was based upon those defects in the patent law; and thereupon the patent association got together, not to attack this band of infringers, but to correct the features of the patent law which were considered objectionable. We are not called upon to-day to attack, and there is no reason why we should fear any attack upon our patent system. We are not here to protect or to attack our patent system.

As an Associaiion we are not called upon to do that; and I do not believe that as an Association, we have got to go into that matter; for that will still be attended to by patent attorneys, and by those who are more directly interested in patent matters. Every interest of this kind in this country is represented and looked after by those who are prosecuting these matters in the Patent Office; and their expenses are sufficiently paid for the purpose. From the reports of every Commissioner for years past, away back at least to the time of Commissioner Mason, every Commissioner has recommended, right straight through, the reformations which are now suggested in patent matters. It is not a new thing. They have been striving year after year, since that time, to accomplish these purposes; and I do not think we ought to stand up here now and take the brunt of that thing, and pay from our Association fund the money necessary to carry such measures through. I simply suggest that, as a matter of policy, as an Association, we drop this matter, except so far as our recommendation goes; and then, as individuals, let us carry it so far as each individual interest deems it to be appropriate.

THE PRESIDENT: Up to the present time the money expended by the Legal Committee has not been taken from the funds of the Association, but has been contributed by voluntary subscription by the representatives of different interests; and there is now remaining of that special fund about $250.

MR. DECAMP: That appropriation was made for two purposes—to meet the expenses of the committee and to procure the publication of our proceedings. The

fund which was contributed for those special purposes is already half expended; the balance is on hand for use for that purpose. If Mr. Leggett will allow me, while I am on my feet I will say that while I am in entire sympathy with the revision of these laws, as stated by Mr. Steuart, I think that we are taking hold of something that we cannot carry out. I think that we will find that the fund required for that purpose will be very largely in excess of what we are able to pay. The small balance of $250 which remains out of that small contribution is sufficient probably to pay the expenses which have already been incurred, and to meet bills to be presented for outlays which have been made. I, for one, do not see how we can carry it any further with our finances as they now stand.

MR. GARRATT: We are undoubtedly much impressed with the arguments which have been advanced, and especially by the mention of the large fees which patent experts have received. (Laughter.) It does not seem to me, however, that the argument is a good one, or that it is the time to abandon this particular subject. It was my misfortune not to have been here when the discussion was opened; and there is one fact which may then have been mentioned, but to which I now wish to refer without making any argument upon it, and it is this, that on the 20th of last month there was presented to Congress a bill drafted for the special purpose of wiping away our present patent system as it now exists, and going back to the patent law as it was in 1796. It does not seem to me appropriate that, with the interests which we all have at stake, we should be inactive in this matter. I own a good many patents;

perhaps they are not worth much, but yet I feel that I have some interest in the patent system of the United States. It may be argued that we are here for no one's particular interest; but any one of us may some day be fortunate enough to get hold of a patent which is worth something; and it does not seem to me to be wise to be indifferent to the efforts of our Legal Committee. It has been argued that to carry on their work will take a large amount of money. It has been argued that suitable experts must be remunerated in a way not commensurate with our means. I would remind the Association—(and I do not do it because the head of the patent department of this Association happens to be a personal friend of mine)—that there has been very much committee work done here which has cost the Association not one cent. It is a common custom for those at the head of a committee to do nine-tenths of the work themselves, and to do it without renumeration. This is expected of them. There are other committees, or have been in this Association, composed of gentlemen whom you well know have been called upon to devote long, hard, persistent work—professional work—without remuneration, which otherwise would have been paid for; but the service has been given as freely as the wind which blows over this house, for the chairmanship of a committee of this Association is an honor of which any man may well be proud. I have no doubt that if it is the desire of this Convention that this movement should go on, the funds will be forthcoming, and this Association will not be left under the great encumbrance of debt, which the previous speaker fears. I do not think that the bill which I speak of, as

being now before Congress, will amount to much, because I happen to know that at the present time it is not backed by very strong men, but it might be; it is a bill which might be promoted by an organized system of infringers, similar to that which supported the attack which was made some ten or more years ago on our patent system; and it might then become an element of very great danger to us all. I do not want to see a blanket of cold water thrown over the work of our Legal Committee, in the face of facts as they now appear. There is one more point to which I wish to refer. The suggestion has been made here this morning that electrical interests have been advanced by the patent system as much as any other interest. That argument was followed by a syllogism; but that syllogism was a false one logically. I do not cast any imputation upon the intent of the gentleman who advanced it; but electrical patents, and electric light patents were used as one premise of the syllogism, interchangeably. Such logic as that is not permitted in the courts, and ought not to be permitted before this Association, for it invariably leads to a falacious conclusion.

THE PRESIDENT: There is one point that I want to say something about in this connection. I do not know anything about the legal phases of this question; nor about any of those outlying ramifications which have been discussed by the gentlemen who have spoken on this matter. That which I wish to call attention to is a fact which has not been commented upon by any of the speakers; and that is that the men who are using these patents, the men who have paid their money for these patents, have found them in a great many instances

absolutely worthless. Now, there were patents, and there are patents; and while Mr. Leggett has held up to you the wonderful success of the Bell Telephone, which I believe has had more piratical attempts upon it, because of its success, than any other patent ever obtained in this country; while he has held up this thing, he has brought in collaterally the protection which has been afforded to our business. Now, I maintain that a proper system in the Patent Office (and I want you to think this over after a while) would make a patent issued from that office just as good as gold—if the system was proper and if proper safeguards were thrown about it. I want also to make this statement—that, throughout this broad land where millions and millions of dollars have been invested in the electric lighting business, there have been very few, if any, favorable decisions in the courts of this country in electric light patent suits.

A voice: There have not been any.

The President: I am inclined to draw it very mildly. I do not want to make any extreme statements. I know that when I get to talking I generally put the bad end foremost; for I want to make my case as easy as I can. The result of that has been—what? It has been that the promoters of electric light companies go into various communities in which they live and solicit their fellow-citizens to put their money into an electric light company. When you deal with a parent company its representatives will say to you, "We have the foundation patents; we have property here; we are not offering you a paper upon which is written down a number of set phrases and words; but

we are offering to you something which is just as good as gold, because we are going to take your gold for it." But what has been the history of these cases? I do not want to reflect upon any representatives of parent companies who are here; but the melancholy fact stares us in the face—melancholy to those who have put their money into electric lighting companies and have got no return from it—the melancholy fact stares us in the face that infringers were men whom they claim, when they were selling their patents were infringers, came into your territory and established themselves cheek-by-jowl with you; and the result was that you found yourself in a few months doing business for nothing; and a promised decision in court was never delivered. Decisions are rarely ever reached in electric light patent suits. Therefore the purchaser of the patent suffers. The parent company, with all this gilt edge work thrown about its business, sells you what? It sells you these patents. Why do you buy them? You think that you are investing in a property which will bring you a good return for your investment. But what do you find? You find that there is no punishment for the so-called infringers. You find that your patents are comparatively worthless. Why is this? Surely the inventor believes and has faith in his invention; surely the men who make these representations to you are in earnest; they are honest; and they believe what they tell you. But that which they tell you is not true. The stern logic of facts and bitter experience which has buried electric light company after electric light company, which have gone down in darkness and financial ruin, are the tombstones

all along this road which show where the contents of men's pocketbooks have been scattered by the way. Where is the fault? If the fault is not with the men who have urged you to buy their wares, it must be in the Patent Office. These are the conclusions which laymen come to. These are not the coclusions of the lawyer; but they are the stern conclusions of those who have lost their money by sinking it in these speculations (that is the word—"*spezulations*"), when they thought that they were engaging in a fixed and substantial business; it is the stern conclusion which these gentlemen who have invested and lost their money that there is something wrong in the Patent Office. I am not speaking for the man who possesses a patent incubator, or for the man who has a patent plow, or a patent harrow, or a patent washing machine, or a patent cider press, because I permit to each of them the same liberty of speech and action which I ask for this Association, and for its members individually; but I say that what we want to do is to protect our own interests as far as lies in our power; and we cannot protect them by sitting idly by and seeing this thing going on. We must act. I want to refer to the lawyers once more; but I do not want to do it unkindly or have them think that what I say is intended as a reflection upon them individually. If there were no sick men there would be no need of doctors. If there were no imperfect laws there would be no need of lawyers. (Applause.) And, just as far as you protect the work of the Patent Office, just so far as honest safeguards can be thrown around these papers which come to us with the broad seal of our country upon them, as the signs of protec-

tion to men who have invested their time, their money and labor in bringing out something for the benefit of mankind (and incidentally for their own pockets as a matter of course)—just so far as these things can be remedied, just so far will Othello's occupation be gone; and the lawyers will have nothing to do. (Laughter.) Perfect the patent laws and there will be no use for patent lawyers. I am talking outside of lawyers, and in the interest of this Association and of the members of this Associatiou, and I say that the paltry dole that you spend in aiding this legal committee—whether it be $250 or $5,000, would be money well spent if it only succeeded in bringing before Congress a discussion of this thing, in such a way as to lay bare the impositions which have been laid upon inventors and investors, and the frauds which have been perpetrated upon men who have invested their money in patents. (Applause.)

Mr. Leggett: I do not see that the remarks of our worthy President alter the conditions or the facts at all. The suggestion was made by the gentleman upon my left that good laws will not stop litigation. Good laws are just as easily infringed as bad laws. The fact that a law is good does not stop the breaking of it by this or that individual. It can be broken just as much, whether it is a good or a bad law. It all comes back to the old proposition: What have we to do with it? Where are we materially injured in this matter? Not by the fact that the Patent Office, seeing that we have a good invention, gives us a patent for it; not by the fact that the Thomson-Houston Company comes along a while after and induces the Patent Office to give them a

patent for an improvement on our invention. The suggestion was made by our worthy President that because the Patent Office issued a patent, it ought to stand still and never issue another patent which would infringe it. That, it strikes me, would be the very worst policy in the wide world. It would be suicidal. Where would it have left the sewing machine? It would have left the sewing machine with the Elias Howe invention—a needle with the eye at the point and with mechanism which could not drive it through a hundred stitches. That is exactly as the sewing machine would have been left at that time. What followed right after that? Another man came after who saw that the breaking of the thread was caused by the fact that as the needle passed through the cloth, taking the thread with it, it made a larger hole, and thus an abrasion was thrown upon the thread and it broke. What was the next thing done? There came along a man who made a little groove above the eye of the needle; so that as the thread passed down through the cloth the thread lay in the groove. What would have been the result if the first patent had stood in the way of all improvements on the sewing machine?

THE PRESIDENT: Let me say a word. There was nothing in my remarks intended to prevent anybody from making improvements on base patents.

MR. LEGGETT: I concede that; but is not that just exactly the situation which throws these competitors into our market? It is precisely that and nothing more. The man came out with a sewing machine having the eye in the point, but no groove. Another man makes a groove above the point and nothing more. But that

was not enough to make it a perfect machine. It occurred to another man to make a groove right below the eye. He got a patent for that. A needle having a groove above, and a groove below the eye, into which the thread is pressed, and so prevented from breaking when driven through the cloth· was what made the machine a success, and makes the perfect sewing machine of the present day. Who is entitled to the credit of that invention? Not the first man entirely. The fact that every machine which a subsequent inventor makes infringes every patent which has gone ahead of him, makes no difference. It is for the law to get at that. The law is not defective which gives to the second and third man a patent. It is just so with our electric light patents. The Brush Company came into the field first with patents which were practically the ground patents; and shortly afterwards came Weston, Thomson-Houston, Farmer, and others. Each one of them had something which was regarded as an improvement, a patentable improvement, over some things that had gone before. And the Patent Office gave each of them patents. That was all that the Patent Office could do. It is perfectly proper that it should do this, and not give a patent which would cover all future inventions in the line. These patents came out; and they established electric light plants. Now, the law is brought into play to invoke protection of these ground patents. Now it is asked, what has the law done for us? Why has there never been a decision sustaining an electric light patent? Simply because, as I will venture to say, there never has been but one patent suit involving the electric light

system which has been brought to a conclusion, and that is the one which I suppose is referred to. That was on the annular clamp of the Brush Electric lamp, which was defeated at Hartford, and which will soon be heard on appeal in the Supreme Court? Why was it defeated? Not because the patent law was bad, but because the patent law was good. It was, to be sure, decided upon a point which had not been argued, and if argued the result might have been different. If anticipated by another party it should be defeated; and that question is the very one to be determined by the Supreme Court. Our patent laws, as I have said before, are in good shape. There are certain things which need modification and change,—certain things by which change would greatly improve them doubtless; but it seems to be folly for us to divert the funds of this Association into a channel which will take care of itself. There is no danger of this bill which my friend referred to — a bill giving to the user the right to use a thing if he is an innocent purchaser, being enacted; it is contrary to the Constitution. The same matter has been before the Senate of the United States time and time again. Unconstitutional measures are seldom passed by the Senate of the United States. They stop before they reach that point. We have a right to expect that the law-makers of the nation will take care of those things when they come properly before them. All these little things, such as this, frighten nobody, for they amount to nothing. Such a bill will probably never get through the committee even, because the committee generally has a good constitutional lawyer upon it. It

is a bug-a-boo. I simply reiterate the statement which I made before that we ought not as an Association to do more than express our opinion. When it comes to individual action, then let each one act for himself, and contribute as much as he sees fit.

MR. FOOTE: Your remarks, Mr. President, about the enactment of an ideal law, or a perfect law, calls to my mind the fact that some years ago a person who has been said to be pretty wise, wrote on a tablet of stone a perfect law, "Thou shalt not steal." Now, if that law had the power within itself to give the protection which you seem to think would come from a perfect law, there would be no need of lawyers in the country now. (Laughter.) I do not expect, gentlemen, that we can get from a committee any greater wisdom than was supposed to belong to the one who made that law; and therefore we need not expect any more perfect law than that. While I am in sympathy with the objects sought to be gained by this movement, I am also entirely in sympathy with Mr. Leggett in his objection to the methods taken to gain that end. I think, as an Electric Light Association, that we are putting ourselves before the public somewhat in the light of a family quarrel among electric light people on this patent issue. If the patent laws need amending, if there is any improvement to be had in that respect, we must remember that we are only a small portion of the public who are interested in patents and who will be interested in any movement having that object in view. I think that the question should be brought forward by the owners of patents, and not by the electric light interest only. There is somewhat of a tendency in the

public mind even now to oppose monopolies in electric lighting, as in telephones; and if we take up the issue individually we are liable to enhance that feeling rather than to allay it. Therefore I think that we ought simply to recommend that an Association be formed representing all the owners of patents; and that *this* Association, as an Association, take no further action in the case.

MR. DUNCAN: The matter presents itself to my mind in this way: The action of this body so far has been simply this—they have organized a committee to take in hand the subject matter that has been under discussion this morning. They did not authorize that committee to spend a single cent of the funds of this Association; but we did say to that committee: "We give you the moral support, the moral backing, of this Association. We believe that it will be a good thing not only that this Association shall be at your back, but we authorize our Legal Committee to go outside and to interest other parties in bearing the brunt of the financial fight which will have to be made." That is the action of this Association up to the present time. Your committee has made its report. This committee states that they have not spent a single cent of the general funds of this Association; but they have asked for voluntary contributions from parties who are interested in this matter and that they have received meagre responses to that appeal; that they have spent judiciously and well the amount of money that has been put at their disposal; and that they have in their treasury $250 to be used in further efforts. The simple question now presents itself to this Association: Will we still further support

ur committee in the efforts which they have made or ill we lay the whole question upon the table as has een suggested? What would be the wisest course to ke? If this Association is convinced, as a body, that individual members they have an interest in this atter, that they have a right to subscribe toward the rposes which that committee has in view, but that ere is no obligation upon this Association to financially ck up this committee, and that they simply use the gal Committee of this Association as an organized mmittee to obtain support outside, as well as to aid ir own individual efforts in that direction—then what he wisest method of procedure? Is it to stop right the middle of the effort which is being made, and npel the committee to say to the people who they ve attempted to interest in this matter: "We have ne so far, but our Association has no back bone; y do not believe in this thing; and they have laid s matter upon the table." Or, will the Association, a vote, approve the course of its committee in the st, telling it to go on as individual members, and we ll aid them? Or, will the Association simply lay the ole question on the table? That is the way the tter presents itself to my mind.

MR. LEGGETT: I offer the following:

Resolved, First—That the matter of patent legislation discontinued so far as relates to any action by this sociation as a whole; and that it be confined to an pression of opinion. Second—That the Association nds be not diverted to that end.

THE PRESIDENT: The resolution of Mr. Leggett is

before you. What disposition will you make of it. It is in order to make a motion to adopt the resolution.

MR. FOOTE: I second that resolution.

DR. MASON: I move, as an amendment, that the thanks of this Association be tendered to the committee who have so disinterestedly expended their time, energy and influence in advancing what they considered to be the interests of this Association.

MR. LEGGETT: I accept that amendment.

MR. DECAMP: I offer as a further amendment that the committee be compensated for any expense which they may have incurred, and which will stop after this resolution is adopted.

MR. LEGGETT: I accept that amendent.

THE PRESIDENT: The amendments of Mr. DeCamp and Dr. Mason are accepted. Are there any further amendments?

MR. DUNCAN: I move, as an amendment, that the whole question be brought to a direct issue that the report of the committee be approved; that the Legal Committee be continued with the proviso, "But without expense to the Association."

THE PRESIDENT: I understand that to be offered as a substitute?

MR. DUNCAN: Yes; as a substitute for the original motion.

The motion of Mr. Duncan was carried.

DR. MOSES: We have the pleasure of having with us today a gentleman of distinction in electrical matters —Prof. E. L. Nichols, the successor of Prof. Anthony at Cornell University. I hope that the privileges of the floor will be extended to him; and I would also sug-

gest, since amendments are in order, and are flying thick in the air at the present moment, and move, that we request him to allow his name to be added to the Committee on Insulation, in order that we may obtain the advantages of having such a laboratory as that of Cornell University at our disposal. I would also suggest that the name of Mr. E. G. Acheson—a gentleman whose name has been brought prominently before the electric world recently as the inventor of a very beautiful heat transformer (transforming heat into electricity), be also added to that committee.

MR. DUNCAN: I would suggest, before that motion is put, as it might be construed as conflicting with the constitution, that the gentleman allow me to amend his original motion by moving that the two gentlemen whom he has named be made honorary members of this Association; and then they can be appointed upon the committee.

DR. MOSES: I think that Mr. Acheson is already a member.

MR. DUNCAN: Then I make that motion as to Mr. Nichols.

DR. MOSES: I second that motion.

THE PRESIDENT: The motion is to elect Prof. Nichols an honorary member of the Association. The Secretary states that Mr. Acheson is already a member.

The motion of Mr. Duncan was agreed to, and Prof. Nichols was declared elected an honorary member of the Association.

THE PRESIDENT: We will now take the vote on the motion of Dr. Moses, that Mr. Nichols and Mr. Acheson be added to the Committee on Insulation.

The motion was carried.

THE PRESIDENT: Before reading the next paper, I would suggest that the recommendation of the committee as to an amendment to the Constitution, increasing the dues from $10 to $20 per annum, be taken up. That was put second on the list of business this morning, but owing to the interesting discussion which has taken place it was overlooked. Mr. Duncan will report the action of the committee in respect to that recommendation.

MR. DUNCAN: Your committee offers a substitute for Article VIII. of the Constitution. The present Article reads as follows:

"The membership fee of each member shall be $10 —which shall accompany the application.

"The annual dues shall be $10—payable in advance and shall cover the calendar year."

Your committee are unanimous in recommending the striking out from that Article of all requirement as to an initiation fee, and making the Article read as follows:

"The annual dues shall be $20, payable in advance, and shall cover the calendar year."

In presenting that report I desire to state that the committee had in view the increased expenditures of this Association. A careful estimate of the cost of printing the proceedings of each session of this Convention is that it will be about $400—possibly a few dollars less, and possibly a few dollars more, according to the size of the pamphlet which the Executive Committee may order. As we have two meetings a year, the cost of printing alone to this Association will be

somewhere in the neighborhood of $800, and the expenses of the two meetings of this Association for various incidental expenses connected therewith amounts, as near as a fair and equitable basis of calculation can be made, to $695. Therefore we have, outside of any salary to the Secretary and Treasurer of of this Association, a necessary expenditure of about $1500 per year. In discussing the financial condition of the Association a day or two since, the Executive Committee arrived at the conclusion that the interests of this Association demand that it must have a Secretary and Treasurer who will devote his time to the interests of the Association, in the way of procuring new members, in carrying out the orders of the Executive Committee in preparing matter for the meetings of the Association, and in general in giving more attention to the duties of Secretary and Treasurer than have been given in the past. I want it understood, in this connection, that there is no reflection intended upon the present or past Secretary, who, as this Association has not been in a position to pay them a proper recompense and maintain them as regular salaried officers, it could not be expected that they would give their whole time and attention to the matters belonging to this Association. Therefore we estimate that in addition to this sum already stated, viz.. $1,500, we should have a paid officer of this Association who will devote his time and service to its interest under the direction of the Executive Committee. We think that a competent man for that position should have a salary of at least $1,000 or $1,200 a year. Therefore the total expenses of the Association will amount, as nearly as we can

calculate, to between $2,600 and $3,000 per year. We have now 178 members in good standing. At an assessment of $20 per year it will bring us a revenue of $3,560. So you can see that, with the increasing interest in this Association, and the growing desire to promote its interest on all sides, and increase its membership, and the desire to see that these discussions are printed promptly, and that the Executive Committee and the committees that are appointed by this Association may reach out and carry more effectively into conclusions and results the work that is mapped for them from one semi-annual ssssion to another—we think that $3,650 is not going to be too much for defraying the expenses of this Association. On the other hand the committee is of opinion that there is no member of this Association who will not receive far more than $20 in benefit from being a member of it. Having these two objects in view your committee unanimously recommend this article to your consideration and for your adoption. I move the adoption of the amendment.

DR. MASON: I second the motion.

MR. LEGGETT: I wish to suggest that, in view of the increase of the annual dues, the membership fee be abolished.

MR. DUNCAN: That is what the committee recommends, and I so stated.

MR. LEGGETT: I did not so understand you.

MR. DUNCAN: The amendment wipes that out altogether, and leaves the article referring only to annual dues.

THE PRESIDENT: Section VIII. is to be stricken out,

and in its place the committee recommends that this be inserted: "The annual dues shall be $20, payable in advance, and shall cover the calendar year." Article IX of the Constitution provides the way in which amendments shall be made; all of which conditions have been complied with, and the report of the committee is now made. It has been moved and seconded that the report be adopted. It is necessary that all the members of the Association shall vote on this question, as the law provides that two-thirds of those present shall vote for its adoption, to secure the amendment.

The amendment was unanimously agreed to.

DR. MOSES: I rise to a question of privilege. In my zealous, or over-zealous efforts perhaps, to get the benefit of that talent of which we can avail ourselves occasionally, I suggested the name of a gentleman who, I understand, represents a certain interest in the manufacture of insulated wires. It is not the intention of this Association, I believe, upon the formation of special committees to have those interested directly represented. I am requested to call your attention to it. It is an unfortunate thing that when we do have some one who is willing to give his ability conscienciously to the advancement of the scientific ends of the Association, that we cannot avail ourselves of his labors without comment. I would therefore like to have the sense of the Association upon that point. This committee that was appointed upon insulation has been composed so far of gentlemen who are entirely independent of any influence, as far as the insulation of wires was concerned. They have been connected with no company, and have no other interests at heart than

those of the Association at large. A name has been suggested, and added, I am very glad to say, as a mark of appreciation, I think, as much as anything else; because there were several who were opposed to it, but who did not raise their voices in opposition. It would be well, I think, to have the sense of the Association on the question whether a gentleman should be added to that committee who represents any interest whatever that might come in direct conflict with its report. I would, in case the Convention decides adversely to it, be very glad to make the proper explanations to the gentleman whose name has been offered. If the action of the Convention is to stand, I would like to have that action affirmed.

THE PRESIDENT: How would you reach that conclusion?

DR. MOSES: By a vote on the question: Shall Mr. Acheson (whose ability is recognized here and in Europe as a person quite competent to render us valuable assistance on this subject) continue on the committee, or shall his name, for the reasons expressed, be withdrawn?

THE PRESIDENT: Before putting that motion, let me state the case very plainly. In this country when men are called upon to sit in the jury box to pass upon the life of another, the highest qualification for that responsible place is that they shall know nothing about the matter. We do not want to copy after that method of selecting jurors, in the selection of committees in this Association.

It has been moved and carried that the gentlemen who have been named be added to the Committee on

Insulation. Dr. Moses now suggests, for the reasons he has stated, if the convention think it best, that the name of one of the gentlemen be withdrawn.

MR. MASON: As the matter has taken the shape it has, and in order to bring it to a test, I move that it is the sense of this body that its late action in adding this gentleman to the committee be affirmed.

THE PRESIDENT: I understand that that is offered as a substitute. The motion before you is that the recent action of the convention in relation to Mr. Acheson shall be affirmed.

Mr. DUNCAN: I desire to remind the members of the Convention that these reports, when they come in, are subject to the revision of the Executive Committee, and it seems to me, therefore, that there ought to be no question about adding the gentleman's name to the committee.

(The motion to affirm the action of the Association in adding the name of Mr. Acheson to the Committee on Insulation, was agreed to.)

THE PRESIDENT: As Prof. Liebig is not prepared to present his paper at the present moment, but will be ready at the next session, we will now listen to the reading of the paper by Mr. Schieren, on Leather Belting.

LEATHER BELTING, ITS ORIGIN AND PROGRESS.

In the early part of this century the first attempts were made by English machinists to transmit power by means of bands or straps made of leather; this transference of power from one line shaft to another, needed

a peculiar quality of material, one that combined pliability, solidity, and strength, and leather was the only known substance which suited that purpose. Many experiments have been made since then with other materials such as rubber textiles, wood, paper, and even iron and brass; also belts woven of horsehair, etc., but none have been able to supersede leather, and even to this day it is universally acknowledged that

"There is nothing like leather
When well put together."

Belts made of leather are given the preference wherever they can be used, and it is somewhat strange that the machinery world of to-day knows so little about the origin, progress, and growth of an article that plays such an important part in the transmission of power, as leather belting.

For the benefit of those who have not read up the history of belting, I will give a brief account of the development of its manufacture in this country, and it then will be seen that this branch of trade has kept steady pace with this progressive age. Previous to 1820 and even up to 1835, much of our machinery which then consisted principally of looms, etc., was imported from England and had all the necessary belting sent with it. These belts were made in a very crude way, generally from heavy leather and were cut across the hide, so that all the laps or joints were from the belly part of the hide. These parts were lapped over from six to eight inches and were not cemented, but were sewed together along the edges with white alum tanned leather, similar to lacing; then large heavy

rivets were put in the center, and the whole thing made as clumsy and as heavy as possible.

Old Style Belt.

In those days machinery was run at a very slow rate of speed, the Belts had to bear a severe strain and therefore generally proved unsatisfactory; so much so, that machinists became discouraged and used gear wheels and upright shafts instead of belting. Upright shafting was largely used in Flour and other mills where heavy work was required, as late as 1860.

Belt making up to 1840 was hardly known. Leather Dealers and Curriers, it is true, kept some extra dressed leather on hand for belting purposes, which mill owners and Saddlers bought and made up into belting. All this stock was neither selected nor stretched, and the quality of belting it made can easily be imagined. In 1842, Wm. Kumble commenced the manufacture of leather belting at 33 Ferry Street, New York. He also had a tannery in Frankfort Street, where the bridge stores are now located. The foreman of this tannery, Mr. Fred. Wood, an ingenious and enterprising mechanic, invented some of the machinery necessary to stretch and join a belt in order to make it run smoothly, evenly, and straight. Mr. Kumble gained quite a reputation at this, his new enterprise, and it was not long before he had several competitors. Thus belt making became a separate and distinctive business, and

before long, through Yankee push and ingenuity, we manufactured a belt in this country which was far superior in quality and workmanship, to any made in Europe. Since this we have not lost our advantage, but on the contrary have made such great strides in this line of business, that today it is universally acknowledged that the United States turns out the best belting in the world, and American belting is as much sought after in England and France as the Peep o' Day Yankee clocks are in England.

European belt makers are striving to imitate our methods of making belts, and for this purpose purchase our improved machinery, with which they hope to make a cheaper belt of equal quality and thus drive out American competition.

However, I must return to my subject. My first illustration shows the method first employed for making a joint. This was of course found to be very deficient, and soon an improvement was made which consisted in champfering the end of the under lap, which came in contact with the pulley, so that the belt was much smoother and better.

Old Improved Belt.

Waxed thread was used to sew the belt and light rivets were used in the construction, which made it run easier, but as the leather was not stretched the belts

would stretch all out of shape and the pulleys had to be flanged in order to keep them on. Not until Mr. Wood conceived the idea of stretching leather before being cut into belting, was this trouble entirely obviated and a flange on the pulleys no longer needed.

The inventions of Mr. Wood, however, are now superceded by more valuable improvements which supply the present demand for perfect running belts, and the belts of to-day are as much superior to the belts of Mr. Wood's time, as is the steam engine of to-day is to the steam engine of 1840. When Mr. Goodyear invented belts made of vulcanized rubber, everybody thought that they would in time supplant leather. Rubber belting offered great advantages, being cheaper and made without joints, perfectly even and smooth, and apparently run much easier. However many disadvantages were detected by actual use, and very soon rubber belts took their particular place in the use of belting, and are now manufactured in very large quantities; but for all swift running machinery leather is absolutely necessary and most reliable and generally preferred.

During the war the demand for belting increased enormously and it taxed the facilities of the belt makers to supply the demand. This made them somewhat careless and the quality of belting greatly deteriorated. The aim of the belt makers seemed to be, how much of the hide they could put into belting irrespective of quality. At this time Mr. Underwood invented a method of making belts of pieces of leather, six to seven feet long. He put short laps at both ends and covered the thin and flabby neck leather with splits

which made them even with the butt ends. These belts proved to be total failures and were soon abandoned. Mr. Underwood, however, made many other valuable inventions; his well known copper shank rivets and burrs, placed on the ends of laps to prevent them for raising, are still used by some; and his patent Angular belts created quite a sensation when first introduced. The latter was a novel and ingenious invention. Great power could be transmitted with narrow Angular belts, but they have outlived their usefulness and are now supplanted by other later inventions.

In the midst of this great demand for cheap belting, Mr. Joseph B. Hoyt revolutionized the trade by going to the other extreme. He gave orders that all of his belts should be made with short laps only, that the butt lap should be joined to the shoulder lap, to accomplish which the whole shoulder had to be cut away. He ordered also that only thirty-six inches of the centre of the hide should be used, and that every width of belt should be stretched by itself. This was a most radical change and startled the trade, while it gave Mr. Hoyt a world-wide reputation for belt making, which he held until his retirement from business with a large fortune, a few years ago.

Mr. J. B. Hoyt deserves credit for having established a *standard* for belting which is reliable and cannot be surpassed, unless indeed the nature of the steer hide changes. The trade everywhere has been compelled to adopt this method of making belts, because consumers have been educated up to it, and many of them will buy nothing else.

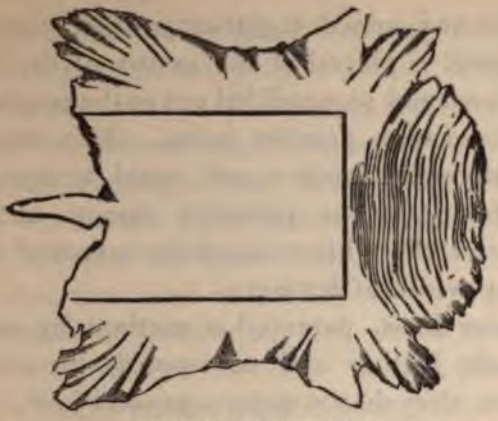


Illustration of Whole Hide.

About 1865 our manufacturing industries developed to an enormous extent and immense factories were erected which required engines of great power, that could transmit from 500 to 1,000 horse power. This created a demand for very wide main driving belts, and great difficulty was experienced by belt manufacturers in making wide main driving belts over 36, which would be of uniform solidity and equal tension. Whole hides contain on an average thirty-six inches in width, of solid leather, and never exceed forty-five inches, while orders came in from all sides for main driving belts from fifty to seventy-five inches in width. Ever since this time experiments have been made on wide belting, and to-day we have reached such a state of perfection that leather belts of any desirable width can be constructed.

A main driving belt is now generally made on the following plan: Take for instance a double belt six feet wide.

The lower or running part of the belt consists of two pieces of leather of equal widths, cut from the centre

of the hide and joined together parallel; then a thirty-six inch piece is placed in the centre of the lower two belts, and two end pieces filled out to the required width, and all joined with parallel joints. This makes a belt of uniformly solid leather and equal tension, and one which is bound to run perfectly smooth and straight. Powerful stretchers have also been invented which can take in any width of leather.

Alexander Bros. patented a method by which they can use side leather and accomplish the same result. However, they do not make a parallel joint, but simply butt the pieces together as above shown, and then cement and rivet the same.

Eastern belt makers were the first to produce a light double belt with neither rivets or other fastenings, claiming that rivets and burs were not necessary if a belt was properly cemented. They were used for machines running at a high rate of speed.

About 1864, M. N. Clark of Boston, Mass., made that line of belting a specialty. He produced a belt which would probably find great favor to-day for running dynamos. His method was to split the pieces of leather to a perfectly even thickness and then cement them together. This made a double belt, rather thin, but well calculated for high speed. Mr. Clark retired from business about ten years since.

Many experiments have been made to combine textile materials and leather in the manufacture of belting. In 1872, Messrs. Clark & Slemmer of Philadelphia patented a belt of this kind. Their method was to stretch a heavy piece of cotton duck of the width required, and place it between two thin pieces of leather

of the same width. This made a strong belt which at first was received favorably by the trade, but which in the end did not wear well because there was two different kinds of material used; the cotton would stretch more than the leather, or vice versa, and the belt would very soon work itself loose, and the cement and rivets break. Very few of these belts are now in use at present. Another method is used which was patented by T. Thomson of Cincinnati, and which is now manufactured by an eastern concern. In this process, as in the other, a heavy cotton duck is stretched, a thin layer of leather splitts cemented over its surface, and then the two sewed together.

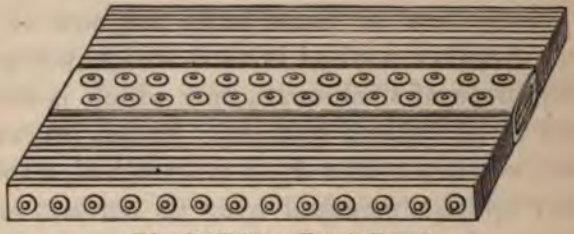
These belts are used to some extent on dynamos. Their main weakness, as already stated, is the unequal stretching qualities of the two materials used, but this objection is not so marked where thin pieces of split leather are used, as above described. The atmosphere, however, exerts a great influence over these belts, and they contract or expand with heat or cold, and cannot therefore be recommended except for easily adjustable machinery. Numerous other patents have been devised but are of minor importance.

EDGE CUT LEATHER BELTING.

Edge-Cut Leather Belting.

These belts are hardly known here but are largely used in England for running machines where slow, heavy and positive motion are required, and they do excellent work.

These belts are made in the following manner: The



Edge-Cut Belting (Howe's Patent).
Shows a device in the center to make the belt conform to the rounded face of the pulley.

leather is dressed and stretched the same as for ordinary leather belting; it is then cut into strips one inch wide and holes punched at distances of one inch from each other, to admit of steel bolts being inserted. These strips are then placed side by side until the desired width is obtained, when they are bolted and riveted together. This makes a belt which is rather clumsy, heavy and stiff, but one that can stand more strain and hard work than any other belt made, and is very powerful.

This audience, however, is probably interested more in the progress and improvement made on leather belting for special use on dynamos and electric light machinery, than in the progress made in any other branch of the trade. I shall therefore describe different styles of leather belts which have met with great success in this field.

When the Electric Light first came into use elec-

tricians found it exceedingly difficult to get a belt suitable to use on dynamos. All the belts which they tried seemed to lack something, and oft-times the heaviest and most carefully made leather belts failed to do the required work. This problem received special attention by some of our most enterprising belt makers, and various methods for making these belts were introduced with more or less success. About five years ago the writer experimented on producing a belt which would be particularly fitted for transmitting power when run at a high rate of speed. I considered the stretching process of leather for dynamo belts the most important, because the steer hide by nature forms a peculiar shape, having fine and solid fibres on the back and then rounding off towards the belly with loose coarse fibres; to get therefore a perfectly flat piece of leather of even tension from the center of the hide, it needs the utmost care.

The wide pieces of the centre are generally put into the stretching strain leaving a short piece free, and thereby stretching the whole piece on an equal strain; or, to explain it more fully, if you wish to stretch a 24-inch centre piece of leather, you place your clamps eight inches on each side and leave the centre eight inches clear; this will draw up enough under the strain of the side pieces to be perfectly even, or rather, the side pieces which contain more stretch, will draw its tension even with the centre.

I also prepared a dressing or extra coating for the leather which made it very pliable and also very smooth by filling its pores. Another important improvement for dynamo belts, was making them light, double and

perfectly even in weight, so that every square inch of the whole belt was of even weight and tension throughout. This caused this belt to run without vibrating like ordinary belts, to run more steady and give a uniformity of power so necessary for producing Electric light. Nor did the belt contain copper rivets and burrs or other obstruction, but simply small wire endless screws; and its tensile strength was greatly increased by fastening the edges of the belt with these wire screws which held the leather firmly together, and yet offered no obstruction to the smooth surface of the belt.

However, no belt has ever created such a sensation in the trade as leather link belting.

This is a comparatively new article in this country, having been introduced two years ago. Since that time so many improvements have been made in this line of belting, that it can now be used on any kind of machinery. During the past two years these belts are doing excellent work. They are made in the following manner: Small pieces of solid selected leather are dressed with tallow and Neats Foot Oil, which acts as a lubricator to the joints of the pins. The leather is then put through rollers and made very solid; it is then cut into small links; this process makes a link of remarkable tenacity and strength, and one which will stand more strain than a piece of hard rolled sole leather. The links are then carefully assorted as to thickness and the belt built up to the required width. It is of great importance that each belt be made up of accurately assorted links, in order that an even width and perfect running belt may be secured.

Fig.3.

Old Style with only One Bolt.

joint is a great improvement in this line of belting. bolts are used to each width of belt, and the two hs ingeniously joined together and forms an un- en surface. This makes a belt which will conform f to any pulley, whether flat, rounded, or cone.

Fig.2.

New Style with Two Bolts.

hey should be run as loosely as possible, and ld not be taken up unless they actually slip. An perienced person upon seeing one of these link s running on a dynamo would naturally think that belt was loose and needed tightening, but these s have such a remarkable grip power, that though n running the upper side of the belt is so loose that

it almost describes a semi-circle, the under side is as tight as possible. Leather link belt will in time find great favor with belt users as they are more pliable than any flat double belt can possibly be made, and for belts running at right angles I claim that they are the only reliable belts for such a position, that will give satisfaction.

My allotted time has expired and I must close and the subject is open for discussion.

THE PRESIDENT: The paper is now before you for discussion. Are there any remarks to be made on the paper which has just been read?

MR. POPE: I would like to ask the gentleman with reference to the wearing of the edges.

MR. SCHIEREN: The first belt which I made up about six years ago, is still running. Before I came to this convention I took it down and told my man to take it apart, to take out about six inches of it, in order to see the elongation. We have kept perfect time as to that belt. The belt is 28 feet 7 inches long; and it had stretched 9 inches in the first three months. After that there was no further stretching. We took the belt down, examined it closely, and found no elongation whatever. This belt is three inches and a half wide, one inch thick, and transmits fifteen horse power under the following circumstances: It has two 38 inch pulleys; and the pulleys run at the rate of 125 revolutions.

MR. POPE: I would like to ask what has been the experience in Europe during the length of time that these belts have been running there?

MR. SCHIEREN: My attention was drawn to these belts when I went to Europe twelve years ago. I

looked into them at that time and thought very little about them. About six years ago I went to Europe again and looked at them and thought better of them. I thought there was something in that belt that filled a gap in this country; and I determined there and then that I would try them here. However, other matters came up, and I did not try them until three years after that. In reference to the experience in Europe I will state that two years ago I was there and met several electricians and got from them some very valuable information with regard to the use of linked belting in running dynamos. Their dynamos there are run much slower than yours here. A great many of them favor these linked belts. They only use one pin there; and engineers told me that it takes four months before the pin adjusts itself to the rounding of the pulley. Although there are several patents there now, they make belts similar to those made in this country. On the whole they speak of them very favorably.

MR. POPE: One other thing suggests itself; and that is, as to the rapidity of the alternating system—running at 1600 revolutions; whether in that case the link belt would be preferable to, or as good as, others.

MR. SCHIEREN: Two months ago a gentleman called on me and said: "Your linked belting has attracted my attention, and I would like to receive some information about it." I am always very glad to meet electricians, always glad to meet engineers or mechanics of any kind; and so I explained to him all about the belt; took him into the factory, and explained the whole process. He said, "My company would like a belt which would run a mile and a half per minute;

can you make a belt which will run a mile and a half a minute?" I said that I would try to do it. I did; and the belt worked successfully. I made it out of very light material. The belt is today running at the rate of a mile and a half a minute, 8,000 revolutions per minute. I suppose that that is the kind of belt that Mr. Pope has reference to.

MR. RIDLON: I have used one of these belts, three and a half inches wide at a speed of 2,000 feet per minute. The only fault I can find with it is the stretching. We took it out two months ago and there has been no trouble since.

MR. RICE: I would like to ask Mr. Schieren in reference to the amount of power consumed by this belt, as compared with ordinary belting. Does the belt itself use more or less power—I mean, for the bending of the belt over the pulley?

MR. SCHIEREN: I am sorry to state that I am not a civil engineer or a mechanic; I am a belt maker. If you come to me and say that you would like thus and so done, I am ready to give it my attention; but if you ask me certain questions—as, can that belt do thus and so at a certain speed?—I cannot answer. My experience in linked belting has been, that it will transmit under certain circumstances more power than the ordinary belt. It will do it every time. In some instances we have put on an eight inch belt and have taken off a twelve inch belt. In some instances we have put on a twelve inch link belt and have taken off a ten inch belt; and it would not drive with a ten inch belt, owing to the difference in circumstances. So to-day I may say that we are ignorant in regard to the amount of power

comparitively that they will drive. We are constantly making experiments and improvements, and are gathering valuable information in that way; but I am sorry to say that I cannot answer your question intelligently.

MR. LAW: I would like to ask Mr. Schieren if he has had any experience, or enough expérience, to determine the amount of damage that oil does to this belt, as compared with ordinary double belting. In some classes of our dynamos a large amount of oil is saturated into the belt; and I would like to know if that has any effect upon this linked belt?

MR. SCHIEREN: So far no claim has been made in that direction. Of course you will understand that if the leather lies on the edge it exposes the fiber of the leather more than if it lies on the smooth surface of the leather. Leather is a great absorber. I use blotters of leather in my office; because leather absorbs a fluid at once. No doubt you have noticed this in running your dynamos. It absorbs oil very fast. This link belt would absorb oil more than other belts do, although I have had no experience. It is necessary that the linked belt be exposed on the edge, and therefore it would absorb quicker than in the other way. But that could be obviated by using a dressing which would close the pores of the exposed part of the belt.

MR. DECAMP: Does not one of the great advantages attending the use of the linked belt lie in the fact that it can be run slack? That being the case, is its use confined to horizontal belts? If that be the case it would be necessary to have the slack side on top, which is not possible.

MR. SCHIEREN: The link belt will only run success-

fully if the slack side is on top. If the slack side is below, the belt will very soon flap on your floor, and your power is gone. They do not run successfully in that way.

MR. LAW: What sort of success have you had with almost perfectly perpendicular belts?

MR. SCHIEREN: We have had very good success. The only trouble with perpendicular belts is this: At first these link belts stretch considerable. I have learned a great deal since I undertook to make belting. I have alluded to these edge cut belts, which are enormously strong. The Englishmen recommend it and use it for their slow, heavy power. I have seen in England, six-inch belting transmit power that I would hardly dare tackle with my 24-inch belting. It was edge-cut belting an inch and a half thick and bolted together. If you take a piece of leather that is three feet wide and one inch thick, and stretch it in a stretching machine, you will stretch probably ten per cent. of that belt under certain circumstances. If you take and cut up that piece of leather into small pieces of two inches, and bolt them together you can stretch it a foot. Why is this? It is because the little pieces seem to have more elasticity than the longer pieces have, or more than when they were combined together. There lies the great trouble in these linked belts. I have studied the question very deeply; and to overcome that I have a certain method of preparing and filling—these small pieces—with a dressing that tends to toughen them, and tends to harden them at the same time, so that it will not stretch as much as the whole piece of leather would. The article of belts

that we make today are filled with that material,—all that they will possibly take,—and the leather is even tougher than steel; it will cut steel.

Mr. Jesse N. Smith: One of our greatest sources of loss of power in fast running belts—that is, in belts running 5,000 or 6,000 feet per minute, is the imprisonment of air between the belt and the pulley. It amounts to carrying the belt away from contact with the pulley; amounting sometimes to a quarter of a revolution, or a quarter of the circumference of the pulley. Experiments have been made that prove that a belt will drive more power if holes are punched through it, than a solid belt will do, when run at high speed. The link belt which Mr. Schieren has spoken of, has, of course, a large number of holes perforated through it. For that reason, it is very easy for the air which is imprisoned between the periphery of the pulley and the inside of the belt, to get out, and permit a very much closer contact. I think it is a fact, and that it has already been proven in a great many cases, that a linked belt will transmit more power for the same width and the same belt, with reference to the exposed part of the pulley, than will an ordinary flat belt.

Mr. T. Carpenter Smith: I can say, in answer to Mr. Rice's inquiry as to the bending strain of belts, that, without having made any particular examination of it, any one who has looked at an ordinary belt running at a high rate of speed will notice that the speed of the belt is not sufficient to overcome its stiffness and make it lie right on the pulley; but a linked belt will in all cases lie right on the pulley, and form a true tangent to the edge of the pulley wherever it strikes it.

The flexibility of the belt is so much greater than that of an ordinary belt that the bending strain is less. With regard to vertical belts I will say that we had a belt of that kind, running 7,500 feet per minute and we found that a link belt while running at that tremendous velocity would carry more power, and stick closer to the driving pulley. They seem to have a peculiar way of sticking to the pulley very closely. I have had very little experience with this belting; but we used one of the eight inch belts, and then we tried a link belt, and it did the work first rate; but we had to abandon it for a very curious reason; and that was that when running the link belt at such a high rate of speed it caused the belt in coming down on the pulley to make such a terrific roar that it made the engineer sick—it gave him a nervous headache; it was due perhaps to the fact that our station was only six feet from the floor to the roof, and with the 300 horse power dynamo in a room only 20x30, it made a terrible noise. But, so far as the belt itself was concerned its work was satisfactory. With the other belt we got rid of that trouble entirely. There are a great many things that come in in the practical work which we cannot see when a thing is designed; and it is not always what seems to be the best thing to put in that you can keep there.

The Association here took a recess until 3 o'clock P. M.

AFTERNOON SESSION.

President Morrison called the meeting to order at 3 P. M., and announced that the first paper of the afternoon would be that of Dr. Liebig on motors.

Vice-President Weeks took the chair.

The Secretary then read a communication from Messrs. Charles Schieren & Co., of New York, donating $50 to the National Electric Light Association.

Upon motion, the thanks of the Association was tendered for the same.

MR. RIDLON: I want to offer the following resolution:

Resolved, That, Article IV of the Constitution be hereby amended to read as follows:

The President and Vice-Presidents shall be elected by ballot to serve during the following meeting. The Treasurer and the Secretary who may be one and the same person, shall be nominated by the President, subject to the approval of the Executive Committee.

The Executive Committee shall be chosen by ballot at each meeting, either annual, semi-annual or special, to hold office from the close of the meeting at which they are elected until the end of the meeting at which their successors are chosen.

MR. MORRISON: I move that that be laid over until to-morrow morning, and taken up as the special order of the day.

The motion was carried.

Dr. Liebig then read the following paper.

ELECTRIC MOTORS.

The development of the electric motor from its primitive form up to the present state of advancement and usefulness has been similar to the growth of nearly all of those great discoveries, which have proved themselves at first so adaptable and then so necessary to the wants of every day life.

The history of the motor is a very remarkable one, not only as a story of rapid improvement, but also because its first chapters belong to recent times.

We can now ask ourselves, not without some astonishment, why it happened, seeing that the laws of the conservation of energy were so generally accepted, that the reversibility of the dynamo and motor was so lately discovered. It is quite true that the first motor was built many years ago, but for a long time even after the dynamo had undergone a very marked improvement, the motor was not turned to practical account. In other words, dynamos and motors have all along been kept distinctly apart, and even to-day there exists sometimes a certain indefiniteness about their relation.

We know that the general term "dynamo-electric machine" includes not only generators of electricity, but also appliances for converting electricity into other forms of energy, and that all the mathematical formulas which have been applied to the dynamo as a generator of electricity are equally as applicable to the dynamo when viewed as a source of motive power. The only changes necessary in our formulas relate to the algebraic signs of certain symbols.

The feature of reversibility is of extreme importance, and means that any rule of construction or of design that tends to make a dynamo machine an efficient apparatus will give identical results when used in connection with a motor. Other considerations may present themselves, questions of speed and output per unit weight of material may arise, and these may be different in the two cases, but they are of a mechanical or at any rate secondary interest, and in no way affect

the mathematical considerations. In what follows, therefore, we shall use the term "dynamo-electric machine" to designate, unless otherwise specified, either a generator of electricity or a dynamo reversed, *i. e.*, a motor.

In order to give an intelligible review of the work done on dynamos, and prepare the way for a few considerations which will follow, it may be well to describe briefly the component parts of a dynamo-electric machine, and refer to the purposes for which they are intended. In every dynamo we must have a combination of the following elements:—

(*a*) An iron body or frame work constituting the magnetic limbs. This is always wrapped over a certain portion of its length with insulated copper wire and its purpose is to produce between its ends or polar surfaces a region of magnetic force.

(*b*) A series of coils of copper wire generally wound upon a subdivided mass of iron, and capable of revolution about an axis in such a way as to make each coil pass successively before the polar surfaces of the magnetic limbs. This is called the armature, and is always so placed that it helps, with the magnets, to form a nearly closed magnetic circuit of iron.

(*c*) A commutator, which is merely the ends of the armature coils brought to one side, and which revolving with the armature effects a change in the direction of the currents formed alternately plus and minus.

(*d*) Several brushes or collectors, usually two in number, consisting of pieces of metal which press upon the segments of the commutator, and which are

in metallic communication with the terminals of the machine.

In general, the armature revolves between the poles of the electro-magnet; but in some machines, notably those intended to furnish alternate currents, the armature is stationary, and the magnet coils themselves revolve. This is, however, immaterial, inasmuch as what we have to consider is the relative motion of the parts of the machine, not their absolute movements.

It appears, therefore, that the dynamo machine since it consists, broadly speaking, of an electro-magnet and a revolving coil of wire is a very simple piece of machinery, yet it has taken years of hard labor and patient investigation to evolve from the spinning disc of Farady the dynamo of to-day.

There is a feature in the history of the dynamo which must appear remarkable to every one thinking of the subject. When we remember how much attention has been directed to dynamo machines, not only by practical but by scientific men, and recollect that all the materials for a complete theory of the dynamo have been for several years at hand, we are inclined to wonder at the absence of such a theory. Even to-day no complete theory exists, though we are in an immeasurably better position in this respect than we were five years ago. For what we know now in so far as it is immediately applicable to dynamos, we are mainly indebted to the labors of Clausius, Hopkinson and a few others. It is sometimes claimed that the theory of the dynamo has been seriously crippled by the want of sufficient knowledge regarding the law of the electro-magnet, namely, the law connecting magnetic force

with the magnetism thereby produced in magnetic bodies. If we admit that an empirical formula is required we must admit the justice of the claim, because no accurate expression of this kind has ever been originated. But we shall see that it is by no means necessary to depend upon empirical laws; all that we require are the curves of magnetism, and these have been before the world for years.

However, we now possess the results of a new series of investigations as to magnetism and a magnetic permeability undertaken at home and abroad, among which the most important are those of Hopkinson, Ewing, Rowland, Warburg, etc. These results, in connection with the work already referred to, make it possible to calculate to a close approximation, at least for certain forms of machines, just what any given dynamo will do when we know besides its dimensions and configuration the kind of iron used in its manufacture.

The words magnetic permeability used above, and which enter so frequently into dynamo calculations are defined by Maxwell (vol. ii., page 50) as the ratio of magnetic induction to magnetic force. It is also called magnetic inductive capacity corresponding to specific inductive capacity in electro-statics.

Following out an analogy in a different direction, it sometimes happens that magnetic permeability is called magnetic conductivity or resistance, the idea being to express the varying resistance, offered by a given body to the production within it, of "lines of induction" as the lines of flow are opposed by a porous solid through which is forced an incompressible liquid. Further we know (Maxwell, vol. ii., p. 51), that the magnetic induction

is related to the magnetic force in exactly the same way that current is related to electromotive force; namely, we have,

$$\mathcal{B} = \mu H \text{ and } C = K E$$

where μ is the permeability and K the conductivity. But the analogy is in a sense imperfect, for whereas K is a constant, in so far at least as it is absolutely independent of the current flowing (leaving all heating effects out of consideration), μ is by no means a constant, but depends not only on the present state of the material in reference to the induction within it, but also upon its previous magnetic history. Thus μ is a variable quantity, and for magnetic bodies grows less and less as the magnetizing force increases. We can, therefore, regard the analogy between $\mathcal{B}$ and H on the one hand, and C and E on the other, as holding good only when H is a very small quantity.

In the calculations applied to dynamos, it is extremely important to know the distribution of magnetism over the polar surfaces of the electro-magnets, that is the number and direction of the lines of induction from pole to pole.

A solution of this problem can be arrived at mathematically in an approximate way only, and then, as a rule, by the consideration of what takes place in the least complex forms of surfaces.

To attain certain ends the graphic method may be applied, either roughly by the use of iron filings, or more carefully by the employment of a small magnet suspended by a silk fibre. By observing the positions assumed by the magnet when freely suspended in dif-

ferent regions of the magnetic field, we can form some idea of the form of the field. For we know that the direction given by the magnet coincides with the resultant direction of the magnetic force at that point (the needle being supposed so small as to exert no disturbing influence) and also that the relative number of lines of force in a small space surrounding the point measures the relative field intensity. The positive direction of the lines of force may be taken as from the north pole to the south pole, both outside and inside the magnet, and they are related to lines of induction in this way: outside the magnet they coincide; inside the magnet they are in opposite directions. This amounts to saying that the lines of induction are continuous, whereas the lines of force are not.

Other methods of measuring the field intensity of dynamos have been proposed, such as the magnetometer method. The results so obtained are however inaccurate, and indeed the method cannot be applied at all when the armature is in place. Nor can the very simple pendulum method devised by Sir William Thomson be applied, because the air space between armature and magnets is too small. It can of course be used by removing the armature, and it has the advantage of giving results directly in absolute measure.

Unfortunately, measurements obtained under these circumstances do not give us a reliable basis for calculations, inasmuch as the form of the magnetic field is strongly influenced by the presence or absence of the armature, at least when it contains iron. It may be remarked that magnetic distribution is exactly analogous

to electric distribution, especially in the case of dielectrics, and that the geometrical form which influences the latter plays almost as important a part in the case of magnetic distribution.

We are aware that the density of electricity on a given portion of a charged body depends upon the shape of the body and also upon the presence near it of other charged bodies. The same laws of surface density determining the so-called leakage of lines of force obtain in the case of magnetism. In almost all dynamos the pole-pieces have necessarily somewhat sharp edges, and the number of lines of force obtained per unit area is probably greater at the edges than over the remaining polar surfaces. This number is subject to a change when the armature is in place, and to a further modification when the armature revolves, on account of the change in the direction of the axis of magnetization of the latter. These considerations show us that any system of measurement which will give useful results must be of such nature as to be applicable to the dynamo when in working order. The ballistic method fulfills these requirements; it is sufficiently accurate, and besides involves no special difficulty. We have simply to surround that part of the magnetic circuit of which we want the induction with one or more turns of copper wire connected with a ballistic galvanometer and observe the throw of the galvanometer needle when the magnetism is reversed or reduced to zero.

It is always better to observe the elongation of the galvanometer needle due to a reversal of magnetism. An uncertainty always attends a reduction to zero

owing to the phenomenon of residual magnetism. The galvanometer having once been calibrated in absolute measure, we can from the throw of the needle calculate the value of the total induction within the wire, and the magnetic force is known from the data of magnetizing current and number of convolutions. The experiment is repeated for the different parts of the machine, so that we finally obtain the value of the induction throughout the entire magnetic circuit. Suppose now that we have measured the field intensity and have a value of the induction per unit area, we can, by Faraday's law, calculate the E. M. F. which would be set up in a conductor moving in any manner in the field. The law is this: The E. M. F. produced in a conductor moving in a magnetic field is equal to the rate of cutting the lines of force. If the conductor forms a closed circuit, the E. M. F. depends upon the area of the circuit. Hence, in order to be able to determine the E. M. F. produced in an armature, say, we must know the area of the coils of the armature, the strength of the magnetic field, and the velocity of rotation. Call the total number of lines of induction (flow of force) passing through the armature N and the current y then, we have for the force x acting when the circuit is displaced through the distance $d\,x$, by the principle of the conservation of energy (Maxwell, vol. ii., p. 137):

$$X = +\gamma \frac{d\,N}{d\,x}$$

Hence, the movement is aided or resisted according as the number of lines of induction passing through

the armature is increased or diminished by the movement. The work done during the displacement, is

$$X\,d\,x = \gamma\,d\,\mathcal{N},$$

and if the number of lines of induction is changed from $\mathcal{N}$ to $\mathcal{N}$, we have for the whole work:

$$\int X\,d\,x = \gamma\,(\mathcal{N} - \mathcal{N}).$$

Let us divide both sides of the equation by $d\,t$, and we have:

$$X\,\frac{d\,x}{d\,t} = \gamma\,\frac{d\,\mathcal{N}}{d\,t}$$

as the rate at which work is done. But $\frac{d\,\mathcal{N}}{d\,t}$ is the rate at which the lines of force are cut by the moving conductor and is equal to the amount produced in that conductor. We have, therefore, for the rate of doing work—the activity:

$$\gamma\,e = \frac{E - e}{R}\,e,$$

the well-known expression for the activity of the motor.

We shall now simply refer to the investigations of Clausius,[1] and Hopkinson,[2] as their work though differing in character is of extreme importance. The theories published by these two scientists are distinct and characteristic of the two ways of regarding magnetic phenomena. Hopkinson's method is based upon two fundamental laws of electro-magnetism; one law expressing the relation between currents and magnetic force, the other a condition which always holds for

1. J. Hopkinson Proc. Roy. Soc., 1883.
2. Clausius, Phil. Mag. 1883.

magnetic induction. They are as follows: The line integral of magnetic force around any closed curve is equal to zero, unless the curve surrounds a current, in which case it becomes four π times the total current through the curve; the other is the equation of continuity applied to magnetic induction, which means that a line or tube of induction cannot end at a point in space. According to the last law, therefore, if we find that the magnetic induction has different values in the different parts of the magnetic circuit composing the dynamo, we know that there has occurred a leakage through the air. For instance, the total induction through the armature in every dynamo is less than the total induction through the magnet limbs; the excess has, therefore, passed beyond the limits of the iron body into the air from pole to pole.

The two laws just given furnish a means of constructing the characteristic curve with considerable accuracy, *a priori*; that is, the curve showing the relation between electromotive force and current, for the total induction nearly proportional to the induction through the armature at a given speed determines the E. M. F. generated. The data required for calculating the line integral of magnetic force are: first, the general configuration of the dynamo; specification of the of the kind of iron used; the sectional areas; the lengths of the different parts of the machine; the magnet limbs; armature yoke pole-pieces; and from these the "magnetic lengths" can in general be estimated. The variables chosen are the total induction through the armature and the current around the magnets. Certain co-efficients occur in the equations

expressing the relation between the induction in the armature and that in other parts of the dynamo; they are approximately constant, and can be estimated when their values for a machine of given form are once known. Hopkinson's equation can be thrown in the form,

$$\Sigma l f\left(\frac{v I}{A}\right) 4\pi n c,$$

Σ denoting summation. I is the induction through the armature and the function f depends upon the qualities of the iron in the machine. In a machine in which experiments were conducted by Drs. J. and E. Hopkinson, the difference between the induction through the armature and magnets amounted to about thirty per cent. As an indication of the power of the method and the accuracy with which results obtained from one machine can be applied to dynamos of every different form, it may be recalled that the characteristic curve of the "Manchester dynamo" was constructed before the machine was built, and was found to require no correction afterwards. In this case the dynamo possessed not only an entirely new form, but was also compound wound.

The theory of Clausius is founded upon considerations of a totally different character, and is undoubtedly less readily adaptable to practical manipulation. The theory is based upon Ampere's well-known laws of the action of currents upon conductors; an action which is supposed to take place at a distance and not through an intervening medium, as explained by Faraday, Maxwell, Thomson, and others. Clausius expresses in his fundamental equations the mutual potential of the cur-

rents of the dynamo upon one another, and to determine the magnetic moments of the magnets and armature he adopts, with, however, considerable unwillingness, Frœlich's formula of induced magnetism. This formula has been extensively used, and generally under the form:

$$M = \frac{a\,i}{1 + b\,i}$$

in which a and b are constants and i the current. There has always existed a more or less marked opposition to Frœlich's formula, as not giving results in accordance with experiment though the curve it represents is a practically straight line near the origin. Investigation has shown, and Hopkinson has called attention to the fact that the curve should have a point of inflection at the origin, and hence it must be slightly concaved downward (that is, toward the axis of abscissae) during the first part of its course.

Clausius has remarked that it would be better for a dynamo if the core of the armature remained stationary while the coils alone revolved. Mechanical difficulties, of course, preclude the possibility of such an arrangement; yet, we shall see that other considerations support the views of Clausius. In the case of two machines, one used as dynamo and one as a motor, the author has shown that the velocities of rotation necessary to secure maximum work are not in the ratio of one to two as generally believed, but approach this value as the speed of the generator is increased. This, however, refers to the condition existing when the work done by the generator is not limited. When the work is determined, he shows that there can be no

relation between the speeds of the machines in order to give a maximum of work done by the motor.

Another theory, though scarcely a distinctive theory, has been advanced by Dr. Frœlich, and much work of a theoretical character, besides that mentioned in reference to dynamo-electric machines, has been done; but the most important have been referred to.

There is one point which may as well be mentioned at this place about dynamo construction, which seems to have been the origin of exceedingly contradictory opinions.

It is in reference to the position which the coils of wire should occupy on the field magnets. In some cases, we find the coils heaped up toward the middle of the magnets; in some cases, toward the pole-pieces, while in by far the majority of machines the coils are evenly distributed along the whole length.

Theoretically the latter system of winding should be just as effective as the others, and being less complicated, should be used on that account. Professor S. P. Thomson recommends in his work that the layers should be most numerous around the middle of the magnet limbs; in support of which view, he calls attention to the form and number of lines of force from a straight bar magnet in which there is a leakage all along the bar from pole to pole.

The conclusion, however, is unwarranted and the comparison valuelesss, because in dynamo machines we are dealing with as nearly as may be, closed magnetic circuits, and because the distribution of magnetism under such circumstances is entirely different from the distribution in bar magnets, whether long

or short. The remedy for leakages which do occur is to be found not in the peculiar shape of magnet coils, but in the qualities of iron and lengths and sectional areas of the magnetic circuit.

The question of the regulation of motors now demands our attention, and we shall have to consider the methods adopted to meet the requirements of the two systems of electric distribution now in vogue. We can say two systems, because up to the present, motors have not been successfully used on alternating current circuits whatever may happen in the near future. The two systems known as the constant current or arc light and constant potential or incandescent lamp system, necessitate methods of regulation in motors, which are entirely different. For constant potential work we can use either a shunt motor or a "compound wound" machine. In the latter, the main or shunt coils are in shunt with the armature and series coils, or with the armature alone, the series coils being wound in a direction opposite to that of the main magnetizing coils. This system seems to have been first proposed by Messrs. Ayrton and Perry, and is described at some length in Thomson's book on Dynamo Electric Machinery. Bosanquet (Phil. Mag. vol xv., p. 275) arrived at a law of winding similar to Ayrton and Perry's, but deduced from entirely different considerations. The elementary theory of machines of this type is too well known to require special attention. It is sufficient to say that machines so constructed regulate very perfectly (that is, run at a practically constant speed), and have been extensively used. It is, however, by no means necessary to employ a differential winding of

field magnets as has been mentioned in order to secure regulation. The same results are attained by the use of a simple shunt arrangement, provided there exists a certain relation between the resistances of the shunt coils and armature. Indeed, many constant potential dynamos with excellent regulation have already been made in this manner, and motors on the same principle are rapidly coming forward.

It has been stated that compound wound motors (that is, shunt motors, with series regulating coils) will not run at an invariable speed when the load changes if supplied with a constant current, unless the speed is such as to reduce the efficiency to 50 per cent. or less. The statement seems inaccurate; an efficiency of 50 per cent. having nothing to do with the regulation, as we shall see by examination.

Let us consider the matter for a so-called "long shunt" motor. Call now:

E, Electromotive force of supply.
e, Counter E. M. F. developed.
R, Resistance of armature.
r_s Resistance of shunt coil.
r_m, Resistance of series coil.

Then we have for the rate at which energy is supplied to the motor.

$$\frac{E(E-e)}{R+r}$$

and for the rate at which work is done by the motor:

$$\frac{e(E-e)}{R+r_m} = W.$$

garding now both with W and E, as functions of ounter E. M. F., we have by differentiation:

$$\frac{d\,W}{d\,e} = \frac{E-e}{R+r_m} + \frac{e}{R+r_m}\left(\frac{d\,E}{d\,e} - 1\right)$$

$$= \frac{E-2\,e}{R+r_m} + \frac{e}{R+r_m}\cdot\frac{d\,E}{d\,e}$$

the potential of supply is constant, then $\frac{d\,E}{d\,e} = ,0$ he equation reduces to its first term. In this case, we t once that the differential coefficient of W, with ct to e is positive or negative, according as $E > 2e$ $< 2e$. This means that as the load increases we keep that speed constant by diminishing or strengthg the field, provided the efficiency is greater or less 50 per cent., and this is well known. Suppose that E is variable but that the current is constant; we have:

$$K = \frac{E}{r_s} + \frac{E-e}{R+r_m}.$$

rentiating, we have:

$$\frac{1}{r_s}\cdot\frac{d\,E}{d\,e} + \frac{1}{R+r_m}\left(\frac{d\,E}{d\,e} - 1\right) = 0; \text{ or,}$$

$$\frac{d\,E}{d\,e} = \left(\frac{1}{r_s} + \frac{1}{R+r_m}\right) = \frac{1}{R+r_m};$$

tting $\rho = R + r_m$, we obtain:

$$\frac{d\,E}{d\,e} = \frac{1}{\rho}\cdot\frac{r_s\,\rho}{r_s+\rho} = \frac{r_s}{r_s+\rho}$$

bstituting in our first equation this value of $\frac{d\,E}{d\,e}$, we

$$\frac{d\,W}{d\,e} = \frac{E-2e}{\rho} + \frac{e}{\rho}\cdot\frac{r_s}{r_s+\rho}$$

$$\frac{E\,(r_s+\rho) - e\,(2r_s+\rho-r_s)}{\rho\,(\rho+r_s)} = \frac{E}{\rho} - \frac{e}{\rho}\left(\frac{2\rho+r_s}{\rho+r_s}\right)$$

and, therefore, $\frac{dW}{de}$ is positive or negative; that rate at which work is done increases or diminish increases, according as:

$$E > \text{or} < e\frac{2\rho + r_s}{\rho + r_s}$$

or, according as the efficiency:

$$\frac{e}{E} > \text{or} < \frac{\rho + r_s}{2\rho + r_s}$$

This quantity, in the kind of motor under con tion is nearly unity, because the shunt coils resistance very great compared with that of the coils or armature or both together.

The question of an efficiency of 50 per cent. d therefore enter.

A better way to arrive at some knowledge regulation is to introduce an expression for the into our equations.

If we denote the speed by n, and call T the or work per turn, we have for the rate at whic is done in the motor:

$$W = n\,T = \frac{e\,(E-e)}{R + r_m}$$

This is usually called the activity. Differentiati we have

$$n\frac{dT}{dn} + T = \frac{1}{R + r_m}\left(e\frac{dE}{dn} + E\frac{de}{dn} - 2e\frac{de}{dn}\right)$$

or substituting for T its value in terms of E an rearranging, we have for our fundamental equati

$$\frac{dT}{dn} = \frac{1}{n\,(R + r_m)}\left(e\cdot\frac{dE}{dn} + (E-2e)\frac{de}{dn} - \frac{e(E-e)}{n}\right.$$

Let us examine the case of a shunt motor supplied with a constant current K, and writing as before:

$$K = \frac{E}{r_s} + \frac{E-e}{R},$$

and assuming that the magnets are far from saturation, we have:

$$e = const. \times n N \frac{E}{r_s} = C n N \frac{E}{r_s}$$

N being the number of turns of wire in the shunt magnetizing coils, and C a constant. Solving for E and e, we obtain:

$$E = \frac{-r_s R K}{C n N - (R + r_s)}; \quad e = -\frac{C n N R K}{C n N - (R + r_s)}$$

$$\frac{dE}{dn} = \frac{r_s R K C N}{(C n N - R - r_s)^2}; \quad \frac{de}{dn} = \frac{C n N K (R + r_s)}{(C n N - R + r^s)^2}.$$

Substituting these values in our previous equations, there results:

$$\frac{dT}{dn} = C^2 N^2 R K^2 . \frac{C n N + R - r_s}{(C n N - R - r_s)^3}$$

an equation of the second degree in n, and representing the rate of change of torque. As R is too small to affect the sign of the fraction, it follows that $\frac{dT}{dn}$ is always positive; that is, the torque increases as the speed increases.

Furthermore, as $\frac{dT}{dn}$ is a function of n, the speed, the rate of change depends upon the speed itself, being greater for low speeds than for high speeds. However, the equation is only true within a limited range, for at great speeds, the magnets would be saturated, though the armature reaction would practically change but little.

If we now regard E constant and suppose the motor to be a series motor, we have:

$$e = C\,n\,M.\ \frac{-e}{R};$$

M being here the number of turns in the series magnetizing coils. This may be written:

$$e = \frac{C\,n\,M\,E}{R + C\,n\,M}.$$

From which we obtain:

$$\frac{d\,e}{d\,n} = \frac{R\,C\,M\,E}{(R+C\,n\,M)_2}$$

and substituting as before, we have at once:

$$\frac{d\,T}{d\,n} = -2\ \frac{C^2\ M^2\ E^2}{(R + C\,n\,M)^3};$$

which is of the third degree in M, but negative. Hence, the torque diminishes as the speed increases, and as before $\frac{d\,T}{d\,n}$ is different for every value of n.

Suppose, now, that we have a series motor supplied with a constant current K. Here,

$$e = C\,n\,M\,K \text{ and } \frac{d\,e}{d\,n} = C\ M\ K = \frac{d^1E}{d\ n};$$

$$\frac{d\,T}{d\,n} = \frac{1}{Rn}\left(E - e\left[\frac{d\,E}{d\,n} - \frac{e}{n}\right]\right) = \frac{1}{Rn}$$

$$= [R\,K\,(C\,M\,K - C\,M\,K)].$$

Or,

$$\frac{d\,T}{dn} = o.$$

That is, the torque being independent of the speed is a constant. Finally, let us consider the case of a shut motor on a constant potential circuit. As before

$$e = C\,n\,N \times \frac{E}{r};\ \text{and}\ \frac{d\,e}{d\,n} = \frac{C\,N\,E}{r_s};$$

and by substituting and rearranging, we have:

$$\frac{d\,T}{d\,n} = -\frac{C^2\,N^2\,E^2}{R\,r_s{}^2} = -\text{constant}.$$

In the last two cases, therefore, the rate of change of torque with speed is a very simple expression. For a shunt motor supplied with a constant potential current, the regulation may be excellent, provided $\frac{d\,T}{d\,n}$ is a large quantity, but in no other cases have we even an approximate regulation. For constant current work we require a series machine, and the best method of regulation to be applied to it, so far devised, is a mechanical governor, which automatically changes the number of ampere turns in the field corresponding with the load on the motor. Such a governor need waste but little energy and may be as continuous in its action as desired.

Of the losses which occur in motors, we have in all cases to take account of those which are due to the following causes:—

First.—Heating of wires equal to:

$$C^2\,R \text{ or } \frac{E^2}{R}.$$

Second.—Foucault currents in pole-pieces:

This depends upon the number of armature sections; that is, fluctuations of current, and is generally small unless the Pacinotti form of armature is used.

Third. — Foucault currents in armature. This depends upon $(\text{strength of field})_2$ and in the modern laminated armature may be neglected.

Fourth.—Reversals of magnetism of armature equal $\frac{1}{4\,\pi}$ (coercive force) × (maximum induction) × n × (volume). That is, it depends upon $(\text{strength of field})^2$ and velocity of rotation. No amount of subdivision of armature core can affect this, except in

so far as it modifies the total volume of iron in the armature. However, a low-magnetic resistance is necessary, and to secure this the armature must contain much iron. It is on this account that an advantage from a stationary armature core would be derived.

Fifth.— Momentary short circuiting of armature coils, depending upon coefficient of self and mutual induction of armature coils and strength of field.

Sixth. — Finally, friction in bearings. This is difficult to estimate. If the belt is such that Morin's principle holds true, losses dueto friction are constant.

In self-regulating motors, the speed is constant or nearly so; hence, the causes of the dissipation of energy are confined to variable currents in the conductors and to changing field strength.

These in compound wound and constant current motors depend upon the load, but as we see at once are practically constant for a properly made shunt machine. For a pure shunt machine, therefore, the efficiency, provided the speed does not change, is independent of the load.

Before bringing to a close the few remarks which I have ventured to make on the subject of electric motors, it may be interesting to give a few facts regarding the growth of motor industry, and to point out how various are the demands made upon these machines for manufacturing and commercial purposes.

Through the kindness of the Executive Committee of the National Electric Light Association, I am enabled to bring before you a few figures which will, I trust, act as an incentive to increased activity in this direction.

he committee has addressed circulars to 234 com-
es engaged in electric lighting with the following
tions.

Number of motors in operation.

Size of motor.

Maker's name.

Current used.

Charge per h. p. per month.

Charge per month per arc and incandescent
).

Results as to service.

Customers' opinions as to power and servic e.

s a result, answers have been received from fifty-
companies and from these replies the following
ements have been gathered.

age charge per h. p. per month, 10 hours run	$10.00
age charge incandescent lamp, 10 hours run	13.50
age charge per arc lamp until 10 o'clock	9.83
age charge per arc lamp until 12 P. M	13.00
age charge per arc lamp all night	22.00
est charge per h. p. per month	15.00
est charge per h. p. per month	6.25
est charge per incandescent lamp per h. p	21.00
est charge per incandescent lamp	11.25

he motors supplied with current have been used
the following purposes: Driving ventilating fans,
ar and cuff machines, printing presses, various ap-
tus in repair shops, sewing machines, coffee mills,
hines in gun shops, sausage machines, elevators,
es, pumps, dams, ice-cream freezers, organ bellows,
urtenances in laundries, etc., etc.

izes of motors have ranged from 1-8 to 15 h. p. 26
panies have supplied motors from arc light circuits;

14 from arc and incandescent, and 16 from incandescent lamp circuits alone. In 34 cases, subscriber owns motor and pays per month for current. In other cases, companies own motors and charge rental for same.

Companies are endeavoring to have subscribers own motors in all cases, and pay for the current. Electric light companies are satisfied and willing to enlarge the business. Customers' reports are also very satisfactory.

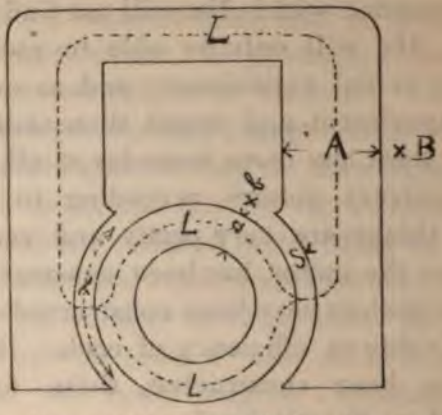
Although the number of cases cited above is small, it is still enough to show us how effectually the motor can supplant the steam engine, especially for those purposes for which the power required is small and under complete control. The opinion of those who have used electric motors indicates that they do their duty well, and encourages us to expect a brilliant future for this branch of applied electricity.

THE VICE-PRESIDENT: Gentlemen, the exhaustive paper by Dr. Liebig on electric motors is now before you for discussion. I should like to hear from Mr. Reckenzaun on this subject.

MR. RECKENZAUN: I feel very much interested in Dr. Liebig's paper; but I am afraid that the formulas which he worked out on the blackboard are not sufficiently practical for every day use. In the course of my experience in constructing motors and testing them I have found that neither Dr. Froelich's nor Dr. Hopkinson's nor any of those elaborate theories have satisfied the conditions. Now if any one attempted to construct a motor on the formulas which Dr. Liebig gave us this afternoon, he would simply get into a fearful maze. He has first of all to ascertain several constants and where is he going to get these constants

from to commence with? He will not find them in any text book. He will only be able to ascertain those constants by actual experiment; and as soon as a man begins to experiment and spend thousands of dollars, he does not want any more formulas at all, but he can at once construct motors according to experience. Now these things are very pretty and very useful to examine after the motor has been constructed, or after two or three motors have been constructed—to examine the relative value or efficiency of each. But until the motors have been constructed, these formulas are absolutely of no practical value.

I thought when I heard that Dr. Liebig was going to read a paper on motors that we, as practical men here, should get some practical figures. With the exception of the resume which Dr. Liebig gave with reference to the number of motors in actual use the rest of the paper, although very interesting, and very cleverly drawn up, is of no practical value. Now I would like to suggest one or two simple formulas which can be applied to the construction of motors. They are not my own invention, but they have been made by Mr. Kapp of England, who is probably known to many of you by name, as he has written the most interesting and most practical book on the transmission of power. I will put some formulas on the blackboard which will be applicable to both motors and dynamos and you have only two constants to contend with. Now as Dr. Liebig told us, the magnetic circuit can be treated in the same manner as the electric circuit.



The magnetic resistance of the horse shoe will be proportional to $\frac{L}{A\,B}$ and that of the armature to $\frac{l}{2\,a\,b}$ each of these fractions being multiplied by a coefficient depending on the quality of the iron used. For dynamos and motors constructed of well annealed wrought iron the strength of the field is represented by the expression

$$Z = \frac{P}{1440\ \frac{2\,S}{r\,b} + \frac{l}{a\,b} + 2\,\frac{L}{A\,B}}$$

Z representing the total number of lines, or the strength of the field within the air space.

The E. M. F. generated in the armature is represented by

$$E\,a = Z\,N\,t\,n\,10^{-6}$$

where $N\,t$ stands for the number of turns of wire on the armature and n, number of revolutions per minute. This formula you will find is applicable to almost every case. I merely mention this, thinking it may be of interest to those members of the Association who

make it a business to construct motors or use motors or would like to investigate the subject more deeply.

Of course I have been accustomed to the slow, humdrum way of doing business in England. You have probably twenty times as many motors in this country at work for all sorts of industrial purposes that we have in England and I feel the time is coming when small steam engines will be entirely supplanted by electric motors, because now as we can construct motors with an efficiency of 75 to 85 per cent—commercial efficiency I mean—it is perfectly natural that there should be great economy in using large steam engines to distribute the power and run machinery by electric motors. Now for any cases where central stations can be put up, small steam engines will soon find their occupation gone.

MR. BRADLEY: Will Mr. Reckenzaun please give us the place where that is found if he remembers it. In what publication will that be found?

MR. RECKENZAUN: This will be found in some back number of the London Electrician. You can also find it in the transactions of the Society of Civil Engineers of London of about two years ago, and you will find a portion of it in Kapp's book on the Electrical Transmission of Power.

DR. LIEBIG: It seems to me that this formula which Mr. Reckenzaun has given and which is certainly a very practical one does not differ to any material extent from the Hopkinson formula.

MR. RECKENZAUN: That is the beauty of it.

DR. LIEBIG: This quantity Z corresponds with the quantity which was estimated by in the equation

I wrote down. All we have to do is to refer to Hopkinson's curves or Ewing's curves. L represents the length of the magnetic circuit, just as L represents it here. In the case of the air space in the armature, we rub out this F which represents the function and we rub out I. In that case the magnetic induction and magnetic force are the same. In that way you can construct a curve which it seems to me is extremely accurate.

MR. H. MCL. HARDING: In regard to certain practical points, we all want to know how much money we can make by selling electric power. Now possibly a few figures which are the reports from about 80 stations which are now selling the electric current for power may be of interest. It is impossible to fix a price for any motor of any given size. That is to say you cannot take a five-horse power motor and charge $500 a year. That you will see a little later is not possible. All of you in trying to sell electric power have met that difficulty. The first thing to do is to divide all the classes of industries you intend to supply, say, into two or three classes: First, constant use. If you are running a ventilating plant and charge about $120 for one horse power, that is constant use. You take next such things as printing offices and machine shops—all work of that kind, which we call partially intermittent. In that case the price has been established—and it would be well, I think, to have a price throughout the country in order to settle difficulties as to what the price of power should be, because the company seems to think that the one who is selling the

motor wishes to have a very low price, and the one who is selling the motor thinks the company wants more than it is worth. First, be sure to sell the machine to the customer. Where motors have been rented the result has not been satisfactory. It has been tried by gas companies. Steam companies have tried renting steam engines, but the engines are never cared for and are in wretched condition, and the same will be true of electric motors, and the repairs of the machines, after they have been run for a long time—not oiled, and neglected, will more than eat up the profits. Take a half-horse power motor; the average price seems to be $75 a year. Of course that is ten hours service. That would be equivalent to about two cents a day, which for sewing machines is not high. One-horse power, $120; two-horse power, $200; three-horse power, $270; five-horse power, $425; seven and a half horse power, $600; ten-horse power, $750, and 15-horse power and up about $70 per horse power per year. If you sell 15-horse power at $70 a year, the intermittent use will show a large profit. These data we have obtained in this way: On every machine running on the constant potential circuit of the Edison Company in New York—also in other places—they put a meter and they examine the meter at the end of each month, and that data has been of great value, because we know exactly how much the customer is using. Take the third class, which is the elevator work, you will find that to be a very profitable source of income. In elevator work for a five-horse power motor, you charge $300 a year. For a seven and a half horse power motor, $360. You can

charge say about $400 for a ten-horse power. Suppose a man puts in a motor of five-horse power for a small freight elevator—if, however, he has a very large platform he can use ten-horse power once to take up a load—you will find he is not using so much current. Now, from actual tests they have found in New York that on a freight elevator charging at lamp rates which is 1 1-5 cents for sixteen candle power per hour, that is equivalent to $312 per horse power per year. The actual amount used very seldom exceeds $150 a year, which shows a very handsome profit indeed. If you calculate that you are selling your power at the same rates as you are selling the lights, then if you can make 10 per cent. by selling your current for four hours per day, if you can sell current for ten hours a day you are making two and a half times as much, or 25 per cent. possibly. These figures may help some of you in establishing the rates which you shall charge for power. (Applause.)

THE VICE-PRESIDENT: Is there any further discussion of this topic? If not, the paper of Dr. Liebig will be received and spread upon the minutes, if there is no objection, and we will pass to the next paper.

MR. FOOTE: I wish to thank the last speaker for his remarks. He has told me exactly what I came here to find out.

THE VICE-PRESIDENT: If there is no further discussion this topic will be passed. We will now take up the next subject on the program—Independent Engines by W. L. Church.

[Mr. Church read his paper and then Mr. Edson read a paper on the speed of engines.]

INDEPENDENT ENGINES FOR INCANDESCENT STATIONS.

Commercial success in Incandescent Lighting depends primarily on the continuous, cheap, uniform, and flexible generation of power.

The service of electric lighting differs from other forms of manufacture in requiring more horse power per square foot of floor space; in requiring higher speeds; in demanding the power in larger units; in compelling a closer and more uniform regulation; and in calling for more rapid and constant extensions. It will be observed that these peculiarities require individual and special treatment in the generation and distribution of power, and engineering practice as determined in other lines of manufacture may be sadly at fault when applied to electric machines.

It has become an axiom among experienced station managers that "the money is made or lost between the shovel and the belt." In other words, other things being equal, the dividend earning capacity of a station is determined by its steam plant to which the electric apparatus is to that extent in the nature of an accessory.

Incandescent lighting has not until recently made a brilliant record as an investment, and much of the disappointment is directly traceable to the culpable ignorance of the principle of steam engineering which has been displayed. A man who will not venture to cut himself a $2.00 vest will not hesitate to exercise his amateur talents on a steam plant, upon the economical and reliable performance of which depends an investment of $1,000,000 and the public service of the city. A long and critical experience in this branch of

industry has grounded the conviction that no incandescent station can hope to be financially successful under the ordinary conditions of competition unless based on independent dynamos belted direct from independent engines. Throughout this paper, therefore, we desire to keep constantly in view the opposite systems, namely, a station containing a given number of dynamos of two or three different capacities, each belted direct from high speed engines of corresponding rating; and, on the other hand, the same station with the dynamos driven from one or two slow speed engines, transmitting their power through a line of counter-shafting and pulleys. Having these pictures well in mind, we inquire:—"What are the essential requirements of a first class steam plant in an incandescent electric light station?" Taking them up in the order of their importance, we unhesitatingly say:—First, and always foremost,

ABSOLUTE RELIABILITY FOR CONTINUOUS RUNNING.

The Electric Light Company contracts to supply the demands of a diverse and exacting public, and that public expects to find its light on tap every moment in the year. Failure of service in ever so small a degree is palliated by no excuse. Complete reliability is the condition of popular confidence and patronage, without which all other economies and excellencies go for nothing.

Again, electric lighting perhaps more than any other industry has its earnings directly affected by the shutting down of its power, since it sustains a direct financial loss for lights out, aside from loss of custom and reputation, not easily regained.

Subdivided power reduces this risk to a minimum, and perly directed and applied obviates it altogether. a station using, 2000 horse power, say, in the shape two large engines, the loss of income in one night the shutting down of one of these engines is equal one half the cost of an independent engine on the ɔdivided plan. In other words, as tersely expressed a manager of experience, a company might better peace of mind, reputation, and cash balance on the ɔks, throw a 60 horse power engine into the scrap e than to shut down the station one hour. The vice of electric lighting is similar to the editing of a ly paper, in that lost time can never be regained. ɔst industries can make up lost time by working ertime and by pushing their business in various ways, t in electric lighting

> "The mill will never grind with the water
> That has passed."

Passing from argument to instance, we cite the recent perience of one of the largest stations in the country, erating in the neighborhood of twenty thousand hts. This station as originally planned was driven m a pair of Corliss engines, each having a cylinder " in diameter by 48" stroke, and belting to a counter aft 4 1-2" in diameter by about 50" in length. From s counter shaft are driven five dynamos, having an gregate capacity of six thousand 16 candle power nps. Clutch pulleys 8" in diameter which are the ans of disconnecting the dynamos when not in rvice, with similar clutch pulleys for the exciters.

The remaining dynamos in the station are each 2500 hts capacity and each are driven by a 200 horse power

independent engine, belted direct. Recently in the middle of the heavy run of the evening, an accident occurred necessitating the immediate shutting down of the six thousand lights, besides doing considerable damage, and involving danger to the employes. It happened that one of the engines with its dynamo was immediately available, and was started within two or three minutes, so as to take up a portion of the load of the large engine. In the same station, at a subsequent time, a key became loose on the valve gear of the engine, necessitating another stop for several minutes. On still a third occasion the crank pin became uncomfortably hot, and was carried through the run only at a great risk and labor. Illustration might be multiplied, but this is used as one among many of the almost evident facts that no electric light station can afford to hang its whole business upon any one source of motive power, particularly when that motive power is distributed through the complex mechanism of counter shafting, involving risk of hot bearings, broken pulleys, defective frictions, and what not, any one of them may shut down the whole station. Had these same dynamos been each belted direct from an independent engine the accidents above enumerated could not have occurred in the nature of the case. We do not assume to say but that accidents of some nature are due in any piece of mechanism, but the division of power and generating capacity into comparatively small units, each independent of all the others, affords a practical means of distributing the danger, so that it is essentially nil in its effects. That is to say, had a stoppage of any one independent engine in a similar

instance occured from any cause, the other engines with their dynamos would easily have distributed the load for a short time, without any disturbance or danger whatever, and the service would have been uninterrupted while the repairs were being made or the difficulties remedied.

It has been incidentally remarked in another paper that independent engines afford a safeguard against danger from short circuits, inasmuch as the current due to the short-circuit will overload an independent engine and slow it down, thus giving warning of the danger. If the dynamo is driven from a single large engine, the motive power will not respond to the short-circuit until it becomes equal to the full capacity of all the connected dynamo, plus the range of power in the engine. Practically, therefore, a single slow speed engine will not feel the short-circuit, but will pull it through until something burns away.

That merit of the steam plant which is most obvious, and which appeals most strongly to the Electric Light Company is, *Economy of Fuel.*

The advocates of large slow speed engines rely upon the supposed superior fuel economy of this type as the sole offset to its obvious disadvantages. All managers unhesitatingly admit the superiority of transmitting the power directly and without loss from the engines to the dynamos, and more or less readily concede that in its performance the high speed engine will equal the running qualities and durability of the slow speed engine. If with this, say they, we could get the steam efficiency of the Corliss type of engine, no man would hesitate to decide in favor of the convenient, compact,

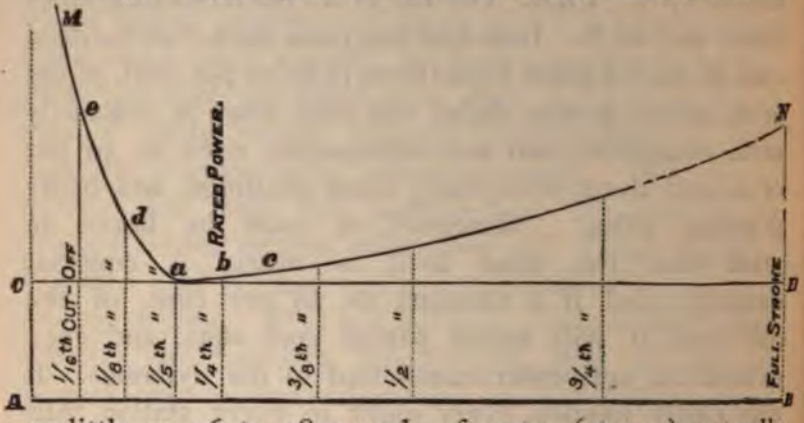
and independent small engine. We take the question at once by the beard, and desire to state that of two incandescent stations operating under ordinary circumstances, and otherwise equal, except only in their power and transmission, that one which has independent direct belted engines will show in its monthly report sheet, not a small amount, but from one-quarter to one-third less coal per lamp hour, than the station driven from a single engine through counter-shafting, both types of engines being non-condensing. We go yet further, and state that independent non-condensing engines under certain conditions will about equal in monthly coal account an equivalent slow speed condensing engine. This is a fact so incontrovertible when actually and candidly investigated, that we do not propose here to demonstrate but merely to illustrate it.

We now submit to the prompt inquiry:—"Will not a high speed engine use more coal per horse power than a Corliss engine?" Yes. "How much more?" Size for size and load for load not over 10 to 20 per cent. Score 10 per cent. against the high speed engine, and again ask:—"Will not several small engines use more steam than one equivalent large engine even of the same type?" Yes. "How much more?" Load for load possibly another 10 per cent. Score 20 per cent. against the high speed engine, and again ask:—How an admitted loss of one pound of coal in every five can be reconciled with the statement of a monthly saving of 25 to 30 per cent. in favor of independent engines? Answer: Simply because we have to deal with conditions as they exist in fact, and not as we assume them to exist.

The reasons why independent engines can overcome ·ir moderate lack of initial economy, and pass a large rcentage of actual economy to their credit, are ıinly two. First. The use of a counter-shaft implies wer to run it. Indicator diagrams show that the dead ıd of such a plant varies from 12 to 20 per cent. of the ɔss horse power under full load when in ordinarily od condition, and not infrequently rises to 30 per nt. and over, with badly lined shaftings, and badly ıwing belts. Moreover, it must be borne in nd that the dead load is nearly a constant antity, and if it amounts to 20 per cent. of the l load, it will under partial load equal and even ceed the net power transmitted to the dynamos. It ıy easily happen, every night in every station thus wered, that from midnight to morning two to three-rse power are expended in the cylinder for each ective horse power recovered at the dynamo pulley. ıus by one stroke and by a single item is the conceded vantage of the larger engines, reckoned in coal per rse power, practically swept away, and large and all engines left standing on an equal footing, prepared submit to the still more searching question:— What is the cost from hour to hour of the power tually expended in meeting the fluctuation of the ıd?"

To consider for a moment some abstract facts in ·am engineering, we must note that the steam engine velops its maximum economy (i. e. minimum con-mption) only over a limited range of its power. ıder normal conditions of pressure, say 80 to 100 ıunds in the boiler, this minimum consumption is

found only between the points of 1-5 and 1-4 cut off, say from A to B, Figure 1, at which latter point all engines are now rated. At its rated power, therefore, the single large engines of the Corliss type will consume

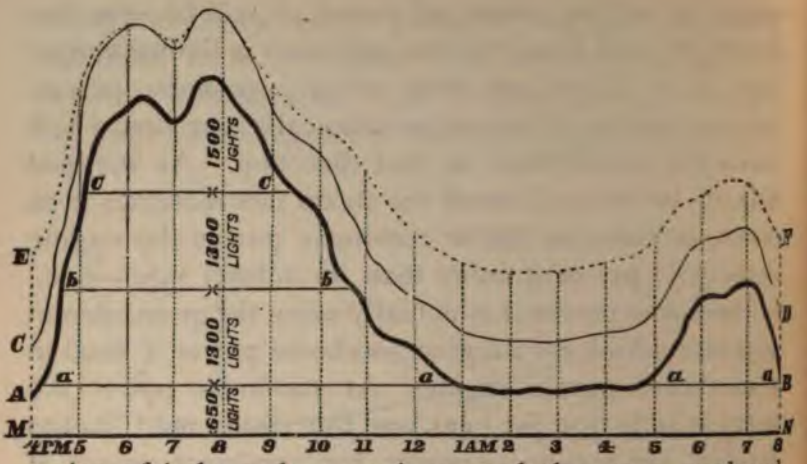


as little as 26 to 28 pounds of water (steam) actually fed to the boilers per indicated horse power per hour, and if the economy were not effected by the load we could represent the rate of consumption by the straight line CD. If overloaded however, the rate of water consumption rises as shown on the right hand portion of the diagram, in which the horizontal distances represented the cut off, and the vertical denominates the actual points of water consumption; the curve, therefore, being a curve of efficiency at varying loads. It will now be particularly noted that whereas the load rises for an overload it also rises for an underload, and very much more rapidly. This is well understood to be partly from excessive condensation, due to over expansion, and partly from the greater percentage of leakage under short cut-offs. Considering Figure 1 to represent the actual performance of a 400-horse power

engine at varying points of cut-off, it will be seen that the engine can be at its best only over a limited range, from A to C, or, say, from 325 to 450-horse power. An overload is, of course, mechanically injurious, which limits the possibilities in that direction. As the load falls off below 1-5 cut-off the steam rate increases in an enormous ratio, so that at 200-horse power the engine is using 50 per cent. more than its normal rate:—i. e., at 200-horse power it is actually using the gross amount of steam which would give 300-horse power if used in a 300-horse power engine. At 100-horse power the waste is fully 100 per cent. and the steam used should develop, not 100-horse power, but 200-horse power, if used in a 200-horse power engine. It must be borne in mind that the diagram is plotted from observation, and is not a diagram of theoretical deductions.

It now remains to determine if the conditions actually obtaining in electric lighting stations are such as will enable a single large engine to develop its normal economy; and if not, then are they such as will enable the smaller independent engine, with a lesser initial economy, to reach a better gross result under the inevitable conditions as they are found to exist.

The typical daily chart of amperes delivered from an incandescent station of, say 4500 lights, is shown in figure 2, of course with variations in different stations, but always of the same general character. The chart is assumed to cover a winter night's run, commencing at 4 P. M., and shutting down at 8 A. M. The heavy irregular line AB represents the fluctation of the actual load, such as would be determined by indicating a



series of independent engines, and the area enclosed between it and the base line MN may be denominated the net power required. The fine irregular line CD encloses the gross load when driven by a single large engine, being equivalent to the net load plus the friction of the shafting and pulleys required in transmission. The irregular band lying between AB and CD, therefore, represents the dead load, which is a net loss, due to the friction of shafting.

But, as shown above, this is not the full measure of the loss. We have already seen in Figure 1, that an excessive underload requires a *relative* amount of steam which would be adequate to produce a much greater maximum efficiency. Combining the two diagrams, therefore, we would find a third dotted line EF, which would clearly represent the actual steam consumption required to secure the net work AB. The irregular band, therefore, between AB and EF represents the total loss expressed in coal. In other words, the entire area E, F, M, N represents the lamps

which should be got for the steam expended, whereas, A,B,M,N represents the lamps actually got for the steam expended. The loss involved is practically 50 per cent. of the total fuel in the whole night's run, which corresponds to observed results in stations whose fluctations of load are about as indicated. Of course there are stations in which the net load averages more uniformly than that shown, and a better proportionate result would, therefore, be expected from the single large engine with countershafting. We believe it safe to say, however, that there is no incandescent station which will get a load so constant as to secure the economy from a single engine equal to that which can be realized from subdivided power.

We now contrast the performance of independent engines in the same station. The lower narrow band between the lines MN and a,a represents the smallest dynamo, or successive loads of 1300 lights each. At starting time, therefore, a 60 horse power engine with its 650 light dynamo is opened, and run continuously until shutting down in the morning. It will be noted that while running, the load on this engine is practically constant and at the point of maximum efficiency. In ten minutes after starting, the load rapidly increasing, it becmes necessary to start the second 125 horse power engine with its 1300 light dynamo, which engine, again, runs on its full and most efficient load, as indicated between the lines a,a, and b,b. This engine is stopped at 12:45, making another short run in the morning, and is therefore, running to disadvantage for about an hour. At 4:40 the increase of lights calls for the third engine with its dynamo, which in turn runs

until 10:45, and is then stopped. The point to be clearly understood as vital to the whole economic question, is, that each engine while running is loaded to its best efficiency, runs only so long as its load is called for, then stops altogether, and with it all consumption of steam, leakage, radiation, wear and tear, and loss of every nature. Ample time is given to inspect the engine and dynamo if necessary, and the system as a whole develops the last possibilities of commercial efficiency.

The above diagram practically represents the performance of two stations which we once had the privilege of comparing, both of which were of practically the same size and both constructed on the same electrical basis. We were by courtesy put in possession of the monthly reports from both these stations, which showed a ratio between the pounds of coal per ampere per hour of 70 to 126 in favor of the station driven by independent engines.

A station whose motive power is one or two large engines, therefore, finds itself in a position of earning money between starting time and 10 o'clock, and spending it again between 10 o'clock and morning.

We have thus endeavored to make it clear in the above illustrations that the rated economy of the two types of engines is but a small part of the consideration, and cuts practically no figure whatever in actual practice under the condition imposed by the nature of incandescent service.

If any one is now unthinking enough to inquire:— Why not use a number of small Corliss engines in place of high speed engines, if it is admitted that the

Corliss type is the more economical of the two?—we would answer briefly. First: small Corliss engines are not as economical as small single valve engines, the percentage of leakage due to the four valves and slower speed being much greater. Second: small engines of the Corliss type run necessarily at so slow a speed as to preclude the possibility of direct belting, and to involve full lines of counter shafting, with their attendant cost and waste of power. Third: the first cost of small slow speed engines is very greatly in excess of that of high speed engines for the same power. We think no one has ever seriously considered, however, the adoption of small indepeudent slow speed engines.

Next in importance to reliability and economy is uniformity, delicacy, and continuity of regulation.

There is much misapprehension regarding the matter of regulation in engines used for electric lighting. Let us, therefore, ask:—What is good regulation? Good regulation implies, as a matter of course, reasonably small variation in speed, reckoned in R. P. M., between the engine fully loaded and the engine running light. Claims are made that such and such engines regulate to two per cent., one per cent. and even one-half of one per cent.. under variations of load. Now, it should be clearly understood once for all that any decent Automatic engine controlled by a shaft governor can be so adjusted as to regulate, not merely to 2 per cent. or one per cent., but to actually pass the point of exact regulation and run faster under load than when light. So far as regulation in terms of R. P. M. is concerned, one per cent. or two per cent.

regulation is sufficiently close for all ordinary purposes.

Second. The most important consideration in the regulation of engines in incandescent stations is not their variation from minute to minute, but from stroke to stroke. An engine may make 300 turns per minute, counted for each successive minute of the hour, and yet may at any given instant be running sensibly above or below this speed, in the effort to meet a momentary fluctuation of load. We say every engine may do this, and we have observed that most engines do this frequently, the difficulty being, not a matter of the construction of the governor, but purely a question of lubrication. A perfect governor is one which will maintain the speed, not at an average of 300 R. P. M., but at the rate of 300 R. P. M. for each and every stroke. Any properly constructed governor will retain the average of regulation to which it is set, but it can only secure instantaneous regulation when friction is practically eliminated. It has been our experience that nothing but a complete bathing of the governor in oil will practically accomplish this purpose.

Incandescent lamps require a regulation more delicate, perhaps, than any other industry. Any departure in regulation from stroke to stroke gives a variation of E. M. F. which is speedily destructive to the life of the lamp, that item which, next to fuel economy, is the heaviest tax. The injury is done during the period of acceleration immediately following the change of load, which period is the time between the change of load and the movement of the governor, and this in turn is proportional to the friction. It is obvious that if friction were annihilated the accelera-

tion would be also nil, and the speed, and consequently the E. M. F., would never vary.

Third. Under the extremely long runs now imposed by electric light service, continuity of good regulation is essential. That is to say, a governor which will regulate when well oiled will fail to regulate when its pins and bearings, being inaccessible under motion, have become dry during a long run.

As to the nicety of regulation obtainable from a slow speed engine, there is no comparison possible. We have already shown that it is not permissable for an electric light engine to vary its speed even from stroke to stroke. All observers know that it is frequently quite possible to count the revolutions of a slow speed engine, particularly when heavily loaded, by the pulsations in the lamps at a distance from the station. A slow speed engine, unless excessive in its fly-wheel capacity, will imperceptibly slacken in passing its centres, and this variation not visible on the engine, becomes a sensible and dangerous variation when multiplied to the speed of the dynamo. The fluctuation of the needle of two volt meters respectively registering from a high speed and slow speed engine will give abundant evidence on this point.

FLEXIBILITY.

The characteristic of flexibility in electric ligh stations is one which is frequently overlooked, until experience, except in stations where the lowest dynamo is small enough for the minimum unit, demonstrates its desirability. To secure the best possibilities in this direction, it is necessary to use dynamos of two or

three different sizes each being driven direct from its independent engine. The plant being thus divided into independent units of different sizes any variation of demand either in the total load or in the load required for different circuits can be conveniently met. Owing to local causes the load of a station is not necessarily the same from day to day. It is obvious that a plant in which all the dynamos are hung upon one or at most two engines is essentially rigid in its control of circumstances, whereas a station planned as above indicated is in the last degree flexible in meeting any variation of load in whatever degree it may occur. All this has a direct bearing both on economy of fuel and incidental of operation.

We would not wish to imply that the smallest unit in every station should necessarily be the smallest unit as determined by the minimum load existing for any considerable time during the day. This minimum load in the majority of medium sized stations will represent about 1-5 to 1-6 the generating capacity of the station. That is to say, a station of 4000 lights capacity should have one dynamo at least as small as 650 lights. Beyond this, it is, perhaps, advisable that the units be uniform for the sake of interchangebility of parts. The whole question of units of generation must be considered, not in the light of any one rule, but under all the circumstances of each particular case.

MAINTENANCE OF PLANT.

The maintenance account of a plant often defeats dividends. In the use of counter shafting an entirely

w factor of expense is introduced, pertaining to the afting, bearings, pulleys, clutch pulleys, belts, etc. Each bearing of the counter shafting will consume l to the value of at least $5.00 per annum, and any nsiderable amount of shafting involves the pay of an xtra oiler to properly care for it. Regarding the two pes of engines under discussion, it is undoubtedly ue that the maintenance of the high speed engine will e fully as low as of an equal horse power in slow peeds, as to its direct expense, without taking into account the time lost in repairs. Nearly all high speed ngines are made to guage with more or less reference o interchangebility of parts. Repairs in consequence re furnished at a minimum of cost, and the parts being ight and readily handled, the engine can be stripped, overhauled and connected up without the employment of an extra force of men or the necessity for heavy handling. In referring to high speed engines we, of course, only speak of those which are carefully and understandingly designed for the work put upon them. That is, we wish to draw a sharp distinction between high speed engines and engines speeded high.

The one danger of high speed engines arises from the possibility of charging the cylinder with water which cannot be quickly enough relieved through the valve at the speed at which the piston travels. The fact that no engineer justly entitled to the name should ever allow an accident of this nature to happen, does not in the public mind shift the responsibility from the maker of the engine. Spring relief valves have now been brought to a state of perfection which leaves little to be desired, when the engine is of a type permitting their use.

[illegible] location.

[illegible] the most considerations which in [illegible] of considerable importance. [illegible] stations are located near [illegible] of the city, where real estate is [illegible] and rates correspondingly high, and space [illegible] the capitalized investment. Again, a [illegible] greatly increases the investment. [illegible] to carry heavy lines of [illegible] must usually be of massive con- [illegible] It needs no illustration to show that [illegible] by doing away with the space [illegible] and belts, under the least [illegible] can be justified, require [illegible] per horse power than any form of [illegible] power. This is particularly the case [illegible] are placed in the second floor, over [illegible]

[illegible] limited space in which the single [illegible] and distributes its power is against [illegible] performance. The fact is generally [illegible] comparisons, that a single large [illegible] manufacturing establishment, such [illegible] is the nature of the case a wide [illegible] to transmit its power from the slow [illegible] up to the high speed of the [illegible] This means that ample space is given to bring the speed up gradual accelerations, through easy moving shifting of substantial nature, up to a moderately high intermediate speed, and then distribute it to the spindles in small quantities by means of simple and light, fast running devices. In the dynamo room, on the

contrary, the space is cramped to the last degree, and the slow running engine must in short range multiply its power to high velocities, and transmit its speed in large units to the dynamos. The whole system of transmission becomes rigid and ineffective, and the loss consequent upon friction, and risk to employees, and the magnitude of disaster when any occurs, are such as in themselves to overbalance all the economy which the most enthusiastic advocates of slow speed engines attribute to them.

EXTENSION OF PLANT.

An electric light station, unlike most other industries, is usually of very rapid and persistent growth, to an extent which is not generally foreseen in the original calculations. The use of independent engines lends itself readily to indefinite extension. The power and dynamos both being divided into like units, each independent of all the others, extension becomes merely a question of more units, without any special preparation in the plan. On the other hand, the slow speed engine with counter shafting is necessarily in large units, and to that extent fails to meet the requirements of a gradual increase. The use of the large engine involves an outlay disproportionate to the immediate returns from the first increase as ordinarily provided for, and it necessitates also the operation of the moderately increased plant at a greater disadvantage on account of the underload involved, as already explained. The practical operator will readily see the force of this important advantage on the side of the independent engine.

FIRST COST OF PLANT.

This consideration, although really of the least importance among those enumerated, is distinctly on the side of subdivided power. The price of high speed engines per horse power is now fully as low, and generally lower, than that of slow speed engines. Cost of foundations is materially less, as is also cost of erection and handling for repairs. There then comes into the question the clear saving of all the money invested in counter shafting, pulley blocks, heavy belting, clutch pulleys, receiving pulleys and similar devices. In the station to which we referred above, the extra transmitting devices necessitated the investment of a sum not less than $6,500.00.

The price thus expended for worse than useless machinery would be sufficient to purchase practically 500 horse power of independent engines, adequate to generate 6,000 lamps, showing a net earning capacity of at least $18,000.00 per annum.

When we contrast this with the net losses due to the system of concentrated power, as above discussed, it leaves no room for argument as to the advantage of independent engines in electric light work.

WILLIAM LEE CHURCH.

ECONOMIC VALUE OF STEAM PRESSURE RECORDS.

The engineer of the present, begins his operations based upon the pressure of steam he is capable of maintaining in his steam boiler. From this he extends his

calculations and elaborates his plans for the prosecution of his work. It matters not what the problem may be, whether it is the grain to be threshed, grist to be ground, hill leveled or mountain pierced, ore raised or office reached, ocean plowed or continent crossed, the same agent, pressure of steam, performs them all. The tropical fruit while rushed to a Northern market is cooled by it, and the plenteous meat of the Western plain is refrigerated during its transcontinental run, and so we see the coal transformed into heat, then into steam and finally manifesting itself in work, in its production of cold, exemplifying the beautiful law of the conservation of energy and making us thankful for the birth of steam. Just now through electricity the civilized world is lighted by it and searching for one greater than Faraday who shall give us a substitute for steam and sound its death knell. So meanwhile we reconcile ourselves to the enormous loss passing up the chimney and stand aghast when the boiler "lets go," scattering death and destruction in its wake, and simply conclude with a verdict of "nobody to blame!"

Investigation and scientific study have done much, however, both for the construction and the safe and economical management of these boilers. Mystery no longer accounts for their explosion, for the conclusion has been reached that "the causes of such accidents can be wholly prevented and controlled," and ignorance is becoming dethroned in her sway to make way for the more intelligent methods of boiler management. The men from our colleges and technical schools demand the facts that they may proceed to their conclusions intelligently. Not theirs, to view the 135

victims of a "Westfield" explosion with "nobody to blame"—for it is not they who beat upon pans and blow horns to scar off the "devil" when the sun darkens. The solar eclipse to them was calculated upon and predicted in advance of its coming. Their verdict will always be, somebody is to blame, explosions are caused by ignorance or neglect.

And so with economy, for to them the furnace will be a sort of gas retort and the burning of coal a scientific study. To them, the boiler, a giant struggling against almost equal odds, harrassed by conflicting expansions and contractions, constant and varying strains, attacked by corrosion and injured by scale. They will know it as a magazine of enormous power in which each cubic foot of water has the explosive energy stored within it of a pound of gunpowder and to them eternal vigilance will be the price of safety. Certainly then it does appear strange, that for such a charge we should employ cheap labor, and that the most ignorant man about the establishment is the favorite fireman. For my part it is incomprehensible how either practical men or those of the usual amount of business sagacity can feel willing to discount the chances against such a course.

The engineer and steam user is confronted with these conditions and should remember that the safety and economy of his "plant" become of imperative importance to his success. In these two connections then, I desire for a few moments the indulgence of your attention, with a view to submitting to your judgment, certain facts bearing upon the importance of providing some method whereby a surveillance over the firing and

the steam pressure may be had, for accurate and full information as to the management of our boilers should always prove useful and interesting.

Upon the question of safety, it requires no demonstration to prove that whatever impairs the boilers' strength or durability should be prevented.

To make such prevention possible, however, presupposes the means whereby the preventable occurrences may become known. If, therefore, fluctuating or excessive steam pressures are injurious how are we to be made aware of their occurrence?

Obviously but one method exists, and that is the resort to automatically steam written records of them and from which we can determine the departure from conservative limits. Assuming that the ordinary steam gauge which only indicates the pressure, at the instant, is entitled to the great confidence bestowed upon it, it undeniably lacks the ability to afford us any more information as to the pressure of the previous moment, than the proverbial dead man, who can tell no tales. In fact for many years, owing to sharp competition they have been so poorly constructed as to be even dangerous to use—so liable are many to rely upon them for the determination of the pressure they are at the time carrying, even going so far as to adjust their safety valve weights to blow with the gauge.

Instead, therefore, of relying solely upon the ordinary indicating instrument, whether it be entitled to such confidence or not, common prudence would dictate the employment of more than one gauge and preferably that the supernumerary should be a recording machine.

The records of steam pressure carried have a large

prudential value for the reason that with their use a fireman must give up his position or do what he is required to. For instance if a careless man lets his steam get too high before he discovers it and the safety (?) valve does not blow as calculated upon from any of the causes common in such cases, who other than the fireman, will be any the wiser and when will the remedy for a careless fireman, or faulty or overloaded safety valve be applied?

It is generally supposed to be necessary to first know of a trouble before its remedy can be either determined or applied.

The only way, therefore, to know whether one's boilers are being exposed to excessive pressure or not is to use a gauge which records the pressure.

Occurrences are constantly taking place under that smooth sounding term, "banked fires," which would electrify every hair of one's head if revealed to those who have so much at stake and think such a fire harmless. A strong fire towards stopping time leaves the boiler setting so hot as to supply sufficient heat for running up the pressure beyond what a cold setting could do. Yet when the fires are once "banked" the man "lets up" on his watchfulness and generally the boiler is left entirely alone for a long interval. "We never carry steam at night as we 'bank' our fires and in the day time have a good, careful man around," is an expression common to most steam users, but a few moments will generally convince them that they have assumed a very ridiculous and untenable position. The police of our cities frequently find steam blowing off from boilers under the sidewalk during their night per-

lations and have learned that it means one of places where they "never carry steam at night," out out somebody in the building or neighbor- to remedy the trouble. One summer recently stopping in a manufacturing town I heard a shrill le blow for two or three hours during the night oncluded, as I learned the following morning, that s a low water alarm. The police hunted up an eer to go to the establishment and give the boiler water and fortunately the boiler took the en- r's proffered kindness without getting up and off out of shape about it, either.

case occurred last October, under one of the cost- buildings on Broadway, New York, where fires anked and they "never carry steam at night." It ared, however, from the recording gauge chart the morning, that something had caused the recorder ake a high steam line for a good part of the night, nvestigation proved that the night watchman heard ring noise when in the top of the building and luded it must be the boiler "blowing" about thing, so he clambered down twelve or thirteen s and found the damper closed and a full pressure Of course, it goes without the saying that if the had been fast in its seat, or the weight shifted on ever from any cause, a first class explosion would followed. The boilers are provided with an ap- ed pattern of damper regulator on the main flue lso have individual dampers on the branches from boiler leading into the main flue. The individual pers are, of course, for shutting off either boiler n not in use. The trouble was caused by the day

fireman, not knowing enough, or forgetting to unhook his automatic regulator connection before leaving at night, and so when the banked fire and heated walls had radiated sufficient of their heat the pressure of steam closed the damper and the heat being entirely shut in and no cold air passage left open to the chimney and little or no steam being used in the building, the "safety valve" was called upon and fortunately did its duty and prevented the steam passing beyond the limit as shown by the chart.

In the same establishment only two months later on New Year's morning the night watchman closed the furnace doors at the usual hour so the fires would be in better condition for the day fireman when he arrived, but the day man did not arrive until some two hours later than usual as it was a holiday and so the steam went up again and startled the neighborhood with the racket for an hour or so. The day man claimed that he told the watchman not to close the doors until a later hour, which the latter denies. Be it all as it may, in both instances the chart, daily submitted to the manager of the property, revealed the occurrences and brought forth an investigation resulting in more correct methods of transmitting orders and causing the unhooking of the regulator while under "bank fires," and also in the night watchman making more frequent visits to the boiler room. Who can deny but that in this instance, their indifferent methods would ultimately have resulted in exploding their boiler had not the recording gauge unmasked the facts and caused the proprietor to set some needed rules in force. If an ounce of prevention

is better than a pound of cure the instrument repaid its first cost in these two instances alone.

Self interest should suggest the use of such a safety appliance, particularly, inasmuch as all persons are supposed to intend the natural consequences of their acts for proof of an act, or course of procedure, which was adopted or persisted in to deceive the public or in defiance of its safety—is sufficient proof of the intent —to deceive and jeopardize unless the doer establishes innocence of such intent and knowledge, and the burden of proof rests on him. If, therefore, it be true that no steam boiler "plant" can be conducted as intelligently, economically, or safely without the information and aid supplied by the pressure recording instrument as with it, then proof of negligence can be made out by establishing the fact that such a valuable monitor and means of information as the pressure recorder had been rejected and failure to secure such competent attention may properly be urged in courts of law as evidence of negligence.

Even so important a matter as the amount of pressure applied by an authorized inspector in testing a boiler with hot water, has shown that only an excess of eight pounds was put upon an old boiler which is regularly carrying from 55 to 60 pounds pressure of steam. The record further shows the pressure to have been "jumped on" for an instant and then released, allowing no time for careful inspection of the seams, etc., while under the testing pressure. No satisfactory reason has been obtained, so far, for this improper method of testing, but the fact has been established, and so much gained. Certainly more confidence could

be reposed in a test where the record shows that the boiler sustained the testing pressure for five or ten minutes, and during which time the testing engineer could be presumed to have been examining the boiler for evidence of effect under such strain.

Another matter revealed frequently by the recording gauge chart is the habit indulged in by many attendants, called "bottling up steam." The most frequent occurrence of such habits takes place at a few moments before the starting time in the morning, and at noon, and in some cases just before cleaning fires. Of course such prejudicial habits are the simple outgrowth of ignorance, concerning the limited amount of steam in quantity they can so bottle up, and the very small service it can render, compared with the injury such practice, when persisted in, ultimately does the boiler. Aside from this objection, the habit is exceedingly pernicious, because only a few moments neglect would cause the pressure to accumulate, to the point at which the safety valve is supposed to open; then, if it happens to be inoperative, an accident is almost certain to follow. No excuse should be taken in any shape, under any kind of reasoning, for "bottling up steam." If the generating capacity of the boiler is not equal to the current demand, it cannot be helped by simply bottling it up. It has been my experience that where the record line has been extremely crooked, upon the first introduction of the recorder, the effect of such introduction has been to cause a much more uniform line from day to day, until the nearest approach to uniformity had been reached, consistent with the vicissitudes of the demands for steam. A

steam user once apologized for the appearance of his record, saying that the steam was drawn from the boiler at irregular periods by persons in the mill and consequently the fireman could not carry any very regular line, that his use of steam was different from that in most places, etc. Noticing, apparently, my incredulity, he asked if I disagreed with him. My reply was, "Do you suppose that the steam necessarily falls as low as this record indicates?" In other words, I called his attention to the fact that where a fireman is on the keen look out for his boiler pressure and water level, he will readily detect the pointer hand on his gauge the moment it begins to rise or fall, and govern himself accordingly. For instance, if he sees the hand indicating that the pressure is falling he will avail himself of the opportunity to slow down his feed, and perhaps open his damper wider, and if his fires are in prime condition, withhold fresh coal for a few moments; then when the onslaught upon his boiler has ceased, and the hand of his gauge is stationary, or starts to move upwardly, he will at once set about it to replenish his coal and water and so have his conditions favorable in a few moments for another attack upon his steam supply. When his steam is rising, he can afford to feed and to fire, and his thought should be to have everything in prime condition while he has surplus power and opportunity. Then he would not be caught so badly when these extreme attacks were made upon him. The cause of these extreme fluctuations then, is largely due to the fact of his being unprepared to meet these emergencies, and becoming alarmed when his steam has fallen twenty or thirty pounds, he

attempts to get it up by replenishing his fire, as it seriously needs it, with coal, which only tends for the time being to reduce the pressure still more until it has been capable of delivering its gases, ready for combustion. After this little explanation, the proprietor shook his head, and said he never had thought of it in that light, and that he would have to call John to him and have a talk with him. Now, the result of this was that from that time on, the man's records never fluctuated in the same manner again, and the average steam line maintained was one which showed constant attention to firing frequently in small quantities, and keeping himself in shape to meet these emergencies. Undoubtedly, the man had to work a little harder at first, but afterwards, it was easier when he properly understood the matter and manipulated his fires accordingly. The suggestion from the proprietor was exceedingly valuable. It resulted in the proprietor teaching his men, and in mutual regard between them afterward, because it showed that the man was capable of being taught and also willing to be, and that the proprietor had evidence of the resulting fidelity. The dissemination of knowledge among firemen can certainly do no harm, and when it reaches a man who desires to hold his position and give satisfaction, it will do much good. Men uneducated to the science of what constitutes firing steam boilers can hardly be expected to use that knowledge which others possess professionally. Some men will fill a furnace full of coal, so as to have more time to walk around; then after a time up goes the steam pressure, because more heat is generated than is wanted; then the feed water is turned on and the water

level run up so as to keep the steam pressure down; the safety valves may blow or not; the damper is closed; the fires smoulder; large quantities of carbonic oxide gas go up the chimney, and this means an escape of unconsumed fuel, which means dollars and cents. After a while, the fires burn lower, and down goes the steam, helped down, it may be, by another dose of coal, and so we can imagine the final effects upon boilers used in such a manner, to say nothing of the waste of fuel. The position of a fireman may be considered an humble one by some folks, but he is a man for all that, and his pride in what he can do is a stronger spur than anything else. Let him see that you care for what he is doing, and take a careful interest in his work, and let him understand furthermore that his own grading depends upon himself, as established by his records; then you are in a fair way to have confidence in your man, and in your safety and also feel assured of economy of fuel. But eventually you must pay him what he is worth. If not, some one else will be glad to have him. Suppose for instance a man who burns three tons of coal a day is paid two dollars for such service and that in so doing he is wasting as little as ten per cent. If coal costs $4.50 per ton, the loss will be $1.35 per day, or what is equivalent to paying a man $3.35 per day who can save this amount, but when amounts of say 8,000 tons per month are used, the saving of only 10 per cent. amounts to $80 per day, and a small portion of which if offered as a premium to the men who use the coal, would go a long way towards saving the remainder of this money. What is wanted is the maximum of steam per dollar's worth

of coal burned. Much can be saved by the manner of its use, and it is within limits furthermore to say that from five to ten per cent. is commonly wasted, while from thirty to forty per cent. is frequently gotten rid of by firemen not qualified as such and entirely ignorant or indifferent regarding the science of combustion. Certainly it is of vastly more importance to a proprietor, both on a score of safety and economy, that his fireman shall be a man trained in the art of properly burning the fuel supplied him than that his engineer shall know particularly if the latter does not impart the information to the fireman. The practical value, therefore, of the steam record is in this connection that it compels the fireman to give close attention, maintain uniform water level and uniform steam pressure and these cannot be had with anything short of the closest scrutiny of the steam gauge which means economy of fuel and safety as well. The explanation of the charts has given much information touching unexpected occurrences, but innumerable other instances might be cited which would only tend to exhibit the surprisingly large number of them possible wherever steam is used, and as these facts become more generally known to those who are not at present deriving the information from such instruments, their use will be extended and more careful methods of caring for steam boilers under pressure will be inaugurated, ultimately resulting in not only greater economy of fuel, but in a greater degree of immunity from those disastrous explosions which destroy so many lives and so much property annually.

JARVIS B. EDSON.

MR. MASON: This paper and the analagous paper which preceded it will undoubtedly call for extensive discussion. We have two papers assigned yet for this afternoon. I move you, therefore, Mr. Chairman, that we now hear the two remaining papers this afternoon, and that we discuss the two which we have heard and these two which we shall hear, to-morrow morning and that the remaining papers to come before us be deferred until the afternoon.

MR. SMITH of Detroit: Will you please state the subjects of the next two papers? I think the paper of Mr. Church is a very valuable one and ought to be discussed.

THE VICE PRESIDENT: The next topic will be Underwriters' Rule, by S. E. Barton. I quite agree with Mr. Smith in regard to the value of the papers read. I think there has been no more valuable paper read before us than these two, and if there is any danger of our losing any of the points I would certainly favor having the discussion of these two topics at once. If, however, we can carry it over, it might be well to do so.

DR. MOSES: It is true that our time is limited as far as the ultimate time is concerned, but not as far as the 24 hours of this day. Those papers are important. Mr. Church's paper requires, I think, a good deal of digestion—not that it is tough in more than one respect, but it is good food—good solid food and needs to be chewed upon by this convention. Mr. Church has had a vast amount of experience in the introduction of these independent engines for incandescent light stations, and we see the result of his work crystalizing—at least

several gentlemen, and I believe the president is one of them, saw in the Westinghouse machine shop a new engine which seems to fulfill all the conditions that he suggests and it would be well for him to speak of that in reply to any comments that might be made on this paper. It would be a great pity, as you say, to interrupt the flow of the blood now. It may congeal. I think we had better proceed and start the discussion on it.

THE VICE-PRESIDENT: If the gentleman's motion is not seconded I will take the liberty of opening these topics now to the convention with the suggestion that every one who has anything to say will say it as briefly as possible. Let us waste no time.

DR. MOSES: I would like to ask Mr. Church then what is about the average size of independent engine that he would recommend.

MR. CHURCH: I think the question is not governed by the size of the engine. I think it is governed by the size of the dynamo, and that in turn is governed by the nature of the circuits which have to be laid out. You have got to discover what your distribution of light is to be; then adapt your dynamos to that; then adapt your engine to the dynamos. It is not a primary question.

DR. MOSES: Is it not in this regard, perhaps? It might not be considered advisable to establish a central station that did not represent a certain curve of use of incandescent light.

MR. CHURCH: Without professing to have any knowledge whatever of the economics of station management it seems to me that a large station will

naturally run in the direction of uniform sizes of dynamos throughout for the one reason that that involves simply the carrying of one line of spare parts, and more ready interchangeability. Of course, in a station in which the light fluctuates as much as in this that I show, the smallest dynamo should be adapted to the minimum load that obtains over the greatest length of time. But I should determine as far as possible what my minimum load was to be, make that my smallest unit, and after that bring all the subsequent units to the same power, or, if found better, to still larger units, as indicated on the diagram.

DR. MOSES: Another question, if you please. Does not the efficacy of these independent engines depend also a great deal upon the simplicity of the engine? If you have a complicated very high speed engine that requires a great deal of attention, oiling and looking out for cylinder heads and all that, is it not, perhaps, advisable to adopt in those cases an exceedingly simple engine? I have in my mind a station I saw in Philadelphia. The gentleman who represents it might now say something in regard to it.

MR. CHURCH: I simply wanted to say with reference to that question that I sometimes play whist. I do not wish the gentlemen present to think that I have returned my partner's lead in this case. (Applause.) I should rather be excused entirely from entering at all upon remarks of that character. I think the Association will do me the credit of acknowledging that I make my remarks as general as possible. It is purely a point as to whether we shall go direct from our engine to our dynamo or shall we go around from the

elbow to the thumb. I would not want to enter into discrimination between engines at all. (Applause.)

DR. MOSES: I feel, Mr. President, as if we are all here for the purpose of eliciting the truth on that matter. I myself am very anxious to know that, because I happened on one occasion to require the use of a high speed engine and found that it was a very difficult thing to manage where the complication of the engine interfered with the ease of mind of the engineer. He had to be running it nearly all the time. His attention was nearly always occupied with it. Therefore I asked that question. I answered it for myself on a subsequent occasion where I caused an engine of very much simpler construction to be substituted for it. I won't tell this gentleman that it was an engine that he represented, or he might object to it. But it was. (Laughter.)

MR. SMITH of Detroit: I think that Mr. Church has treated this question from a very broad standpoint and I think that he should be congratulated on that. There are certainly at least half a dozen high-speed engines admirably adapted for electric lighting, and anything Mr. Church has said on the blackboard in reference to any one of them will apply to all. I do not see any reason for bringing in here the different makes of engines. I am not an engine man myself. I do not represent any engine at all. But Mr. Church's paper was put on a broad basis and I think we should keep it on a broad basis and not bring it down to any particularity.

MR. SMITH of Pittsburgh: Mr. Church's paper is limited to incandescent stations. The use of a small

engine in arc stations has been very much condemned. In an arc station you know about what your load is going to be. If you know your load is going to be 500 horse power you can stop your engine at pretty nearly its full load. There the big engine is undoubtedly the more economical. But in an incandescent station there is no regulation as to the amount of load. We must keep that point clearly before us—that this discussion is limited exclusively to incandescent work. There are comparatively few incandescent stations that are running with shafting, most of them running with independent engines.

MR. KERR: There is another thing, in the preliminary part of this discussion, that I wish to draw attention to. It has been called to the attention of the Association each time a power discussion has arisen, and I do not see the need of mentioning it again except for the fact that a great many men have a misconception of large versus small engines as against sub-divided versus non-subdivided power. Let us not in any discussions that follow here talk about the difference between 60 horse engines and 100 horse engines, and whether it is better to have 60 or 75 or 125 horse power. The thing is a broad matter and not limited to the size of the engine. It is subdivision versus non-subdivision.

MR. SMITH of Detroit: Mr. Church spoke about the economy of small engines as compared with large ones. He is perfectly right in that, because the greatest loss in power is always on the small load. But I think that the question might be carried a little bit farther. The high speed engines, as a rule, are not as economical in coal as the larger engines, for the reason that we can-

not get as perfect expansion; we cannot get as good compression lines on a single valve automatic engine as we can on an engine with four valves as in the Corliss type. But there is another means of getting at that economy which is due to high expansion and that is in compounding. It is known that all the ocean steamers now are run on triple compounds; that is, the steam is taken at high pressure in one cylinder and expanded into the second cylinder and from the second into the third, and the very highest economy that has yet been gained has been attained with those engines. Now the same thing can be done with the high speed automatic engines which we are now using for electric lighting and with very great economy, and the tendency, I think which has already started in Europe is coming to this country and we will very shortly have economical high speed constant revolutions and constant regulating in the engines for direct running of dynamos. There are, as I understand, several of the prominent engine builders now who are bringing out compound engines for high speeds and I think the economy that has been talked about for large slow speed engines will be met in that particular very shortly.

MR. KEER: Mr. Smith has made a remark about which I would like to argue with him, without taking the time of the meeting to do it, about the compression not being as good on a single valve engine as on a four valve engine——

MR. SMITH: Do not let Mr. Kerr forget the idea that I am not in favor of high compression.

MR. KERR: Perhaps it may take but a moment to explain. On a slow running engine you set the ex-

haust valve so that it makes an exhaust closure at 7-8 of the stroke. That does not vary as the load decreases. Therefore the entire internal surface of the cylinder is exposed to the temperature of the exhaust steam at the whole stroke, or 7-8 of it. With a single valve engine, as the cut-off decreases, the exhaust closure occurs earlier, until, when you get down to a very light load, you only expose your cylinder for one-fourth of the time to the temperature of the exhaust steam; and therefore the movement of the compression of a single valve engine not only is better under light loads than a four valve engine, but it is very much better.

MR. SMITH: If I understand it rightly, the lighter the load, the shorter the cut-off, the greater the compression. Therefore a greater surface of the cylinder is exposed to condensed steam than in the other.

MR. KERR: Therefore a less time is given for the bad influence of the temperature of the exhaust steam to be exerted on the surface of the cylinder. This is a long discussion; we will continue it in our next. (Laughter.)

Mr. RICE: Mr. Kerr made the statement that it was not small engines versus large engines, but the division of power versus the non-division of power. Now it seems to me there is not any member here but who would agree to the subdivision of power, broadly taken, in cases where the loads vary largely. We all agree to that. I do not believe any man can dispute that one moment. It seems to me the question comes down to the relative efficiency of the engine direct from the dynamo—a high speed engine—and that driven by means of counter-shafting by a large engine. Suppose you have

a station of 2,500 horse power. Now the question is, is it more economical to use that 2,500 horse power engine or to put in a number of 100 horse power engines; the 100 horse-power engines driving direct; the 2,500 engine driving from a counter-shaft.

MR. KERR: That was the subject of Mr. Church's paper.

MR. CHURCH: I think I did allude to that. I said that the smallest unit should be adapted to the lightest load. I am disposed to take a very practical view of this question. I think there is but one way to settle this thing absolutely and finally, as to which is the most economical, and that is not to argue it from any standard of compression lines or any theoretical data; but to take the results of those stations which operate two systems, and extend it into the cost of the various items per lamp hour. That will settle it. Every well-managed station has its nightly report sheet. Extend the one item of coal alone out to its cost per lamp hour. That will give the relative coal economy; but that is not enough. Then you must extend the collateral items of repairs and all these various items extended out per lamp hour, and then you can combine them and ascertain what the grand total is as to the question of direct or counter-shafted engines. Anything short of that is argument and not demonstration.

MR. WRIGHT: I have recently taken charge of a station in New England, where we are using large engines with counter shafting. We are using somewhere near 5 1-5 pounds of coal per horse power per hour, which I attribute in a great measure to our want of sub-divided power. Of course, there we have an ex-

treme case. But it will not be an extreme case in the future. On Saturday night only do we have an ampere line that approaches anywhere near Mr. Church's illustration. On the ordinary week days we close at 6 o'clock, so that our highest ampere line is maintained for a short time only and then very rapidly falls. I happen to have here with me some papers I brought for Mr. Church. I promised them to him a long time ago, and in preparing to come to Pittsburgh I happened to remember them and copied them to bring with me, and if Mr. Church will allow me for a moment to change his diagram a little bit I will show you where our line comes. I think Mr. Church has shown us conclusively that there is a saving here with the load maintained for several hours at its maximum. Now how much greater must it be if I get a load for five days in the week? That is more like that. (Illustrating.) We are coming to the time when we will all have early closing and our loads will be maintained for a very short time.

MR. SMITH of Pittsburgh: Has any one noticed this peculiarty of our service in Pittsburgh? If it is dark for an hour in the morning, between 9 and 10 o'clock, our ampere curve will jump away up. No matter how bright the day gets after that, it does not drop any. (Laughter.)

MR. KERR: Mr. Church's paper mentioned the difficulty of driving incandescent lamps from very slow speed engines on account of the fluctuation from revolution to revolution. That is a thing which can be noticed in a great many places. There is another thing which goes hand in hand with that. It is quite a well-

know that that a slow speed engine has comparatively small friction. It is generally acknowledged so. The friction of the engine is small. Now put fly wheel enough on a slow speed engine so that it won't make one knock ticker and you will find that it has a very large friction. The reason that a slow speed engine has small friction is because it has not fly wheel enough and the number of tons of fly wheel to give it good regulation makes it a high friction engine. That is a thing which is very little thought of in electric lighting, and when thought of is only thought of too late; when they take out the first fly wheel and put in a second. That applies not at all to our class.

THE VICE-PRESIDENT: If there is no further discussion of these topics the papers will be received and spread on the minutes and the subject will be passed.

We will now hear from Mr. Barton on Underwriters' Rules.

Mr. Barton read his paper.

THE RELATION OF ELECTRIC LIGHTING TO FIRE INSURANCE.

In considering the relation between Electric Light and Fire Insurance interests, I must confine myself mainly to the situation in New England, because I am familiar with what has been and is now being done there, and I am quite as unfamiliar, except in a general way, with the relations that exist between the two interests outside of that small, but lively quarter of our country.

In order that you who live away from New England

may better understand what I may say as I proceed, it will be well for me to tell you briefly, what kind of an insurance organization we have there.

The New England Insurance Exchange, which exercises a modest control over a part of the fire insurance matters within that territory, (with the exception of the City of Boston and State of New Hampshire), is a body composed of the special agents, adjusters, travelling men or so-called "field men," representing the various Stock Fire Insurance Companies doing business there—some one hundred and fifty in number. These men mostly have their headquarters in Boston, which is verily a "Hub" in that respect. They are constantly skirmishing over the territory, individually or in squads of two or more, adjusting losses, and occasionally, through the co-operation of their local agents in the towns and cities, stealing good risks from each other or from some other competitor; but every Saturday finds a large majority of them back in Boston, where they convene in regular session and consider, with legislative dignity, any matters of common interest—electric lights included. They swap experiences, swap yarns, swap anything for something better; consequently they are a body of wonderful unanimity in any cause that promises common good to themselves and justice and fairness to others. They say to electric lights, "burn," after our inspector has approved the manner in which you are installed and maintained; and as a consequence there are in New England to-day, not including Boston and New Hampshire, 13,944 arc and 157,848 incandescent lamps radiating their beautiful bright light where the feeble flicker of the gas jet and kerosene lamp could not penetrate.

So concerted is the action of these men, that were they, by reason of any necessity, compelled to say that electric lights shall not burn, comparative darkness would once more reign supreme in that fair land; but while they can continue to count upon their fingers the yearly fires caused by this modern illuminant, I think I can safely assure you that their dreaded power of extinguishment will not be exercised.

I have made exceptions of the City of Boston and State of New Hampshire, the reasons for which are these: The former, in its fire insurance matters, is supervised by a similar organization to ours, known as the "Boston Underwriters' Union," which handles electric lights in the same manner as our exchange. The latter, through antagonistic and unfair legislation over two years ago, caused the absolute retirement from that state of every outside stock fire insurance company, and they now manage that business by themselves. By what light they work, we know not, but judging from their sad experience of the past year, we are led to believe that they work by the unholy light of their own wicked ways.

I have described the character of our exchange, principally to show the difference between it and most of the insurance organizations of our country, which are generally composed of officers of companies, or local and general agents in the large cities, between whom, by reason of their greater competitive relations, there exists a less cordial and familiar fellowship, and they are consequently less able to harmoniously and successfully devise and carry out methods of improvement and mutual good.

n the first year of our existence, some five years
, we realized, after having paid considerable sums
losses caused by electric lights, that our interests
nanded the inspection of all such apparatus by some
son selected by ourselves, if we were to continue
nting permits for the lights without charge. We
re a year or two, in a sort of experimental way, in
ting settled down to a perfect system of inspection,
the result of the last two years immediately pre-
ing 1887 showed us, for the labor we had
lertaken, a loss of less than eight thousand dollars
n electric lighting, in our territory. We had by that
e not only given up all thought of making an extra
rge for a permit to use your lights, as we do in
ny cases for kerosene oil, and in some instances for
, but we were fast beginning to show our preference
your illuminant by granting reductious in our rates
premium. The year 1887 has shown us a loss
rd from your lights something less than any pre-
s year, notwithstanding the great increase in your
llations, and the spirit of recognition of your
iority in point of safety has steadily gained ground,
I am happy to predict, that before another month
ssed the New England Insurance Exchange will
nnounced its favor in the form of a schedule of
d rates which it purposes to make on certain
of risks where the exclusive use of electric
guaranteed.
k that in this respect we will have fairly taken

position to this end was made by the Electric
ommittee of our Exchange a year ago, but

while we had for two years previous made an occasional reduction in rates, and have done so more generally during the past year, the time has not seemed ripe until now for an open announcement to that effect.

This feeling of preference for electric lights has been very gradual in gaining ground with us, and has reached a general recognition from the fact that the fires from that source have been few in number and the losses small in amount; and this favorable result has most assuredly been due to our perfect system of inspection.

In this claim I am supported by the greatly increased number of fires that are reported as occurring in sections where insurance inspection does not prevail.

That there are in your method of lighting many inherent possibilities of causing combustion and loss of property thereby, I need not claim, because none of you would for a moment deny it; but what I do want to claim, and mean to persist in maintaining, is that there is no reasonable excuse for any fire to be caused by your apparatus, except in very rare cases where some unexpected and unadvoidable accident may occur. It is quite possible for you to reduce the fire hazard of your system to the very lowest degree. It is quite as impossible to do so with any other means of artificial lighting.

How can any care or control be exercised over the promiscuous use of kerosene lamps, while men, women and children, including the careless, the thoughtless, the stupid, the old and feeble, the young and weak, are handling them? What can prevent the innocent, but agile cat from upsetting the lamp carlessly left in its path, as it is not infrequently accused of doing?

Surely no insurance inspector, even with his ubiqutitous habits, could prevent such catastrophe.

While greater care and a system of inspection could prevent many explosions in the gas system, they could not prevent combustible matter from coming in contact with the open flame, neither in the dwelling, the store nor the workshop; nor could they prevent an accidental escape of gas through a leak, or a burner carelessly left open, and in that event no amount of cautionary rules could deter the innocent occupants of the premises from going in search of the leak with an open light in their hands.

While our policies distinctly exclude damage caused by explosion, unless fire ensues, and then only cover the damage by fire, there is usually fire enough to "ring us in," and the drawing of the line between the explosion and the fire is usually disastrous to us.

Therefore I hold that, while no possible human foresight can prevent fires from the old methods of lighting, it is not only possible, but quite an easy matter, to prevent them in your case, if you set about it rightly.

If I were to presume to offer advice in the matter, it would be this: Where insurance inspection is already being practised, combine among yourselves and support it by paying whatever is reasonable for carrying on the work in an intelligent and economical macner; also by helping them improve their rules and requirements from time to time as your experience develops new means of safety.

Where such work is not being performed, get to-

gether in the same manner, those of you who are operating in that field, and ask the insurance men to appoint an inspector; then submit your work to him, conform cheerfully to his reasonable requirements, and go to the public with his approval. The approval by insurance companies of any lighting, heating or power device, is necessary. The public wants light, heat and power, but it must have insurance, for on that the great commercial fabric of to-day depends for solidity.

By such inspection you will bring the fire hazard down to the minimum; you will largely increase the growing confidence of the public in your lights; you will rapidly clear away any lingering prejudice with insurance men against you, and in place of opposition that you may now occasionally meet with from them, you will readily obtain their fullest endorsement; more than that even, you will doubtless receive positive encouragement from them in the way of concessions in rates, in many cases.

The two interests should harmonize and work together to the greatest degree. You have in your system of artificial lighting great possibilities of reducing the enormous fire waste considerably; while we have, through our endorsement and encouragement, the power to largely increase your development; and the two together can give mankind more light and better light, and it needs it.

I do not hold that you are deficient in any degree as to what does and what does not ensure safety in your work, but I think that you will agree that in the construction and maintenance of your equipment you are sometimes obliged to depend upon those who are not

so proficient in their calling as they might be. The good insurance inspector, who gleans his knowledge and experience from all, helps you to educate and improve in usefulness those employes to whom you entrust your work. I refer particularly to the construction and dynamo men, and the trimmer,—to the latter more particularly. If this functionary had possessed a knowledge of the possibilities of fire from the arc lamp, the losses from electric lighting in New England last year would have been too inconsiderable for mention.

Right here I wish to speak of the habit that sometimes possesses local companies,—that of hiring inexperienced help because it is cheap. It is false economy, I think.

Competition, which is very great among you, drives you in some cases to lowering the standard of your material and work. It compels you to figure in every possible way to get the job. Nine of you may be honestly inclined to maintain the highest degree of perfection, but the tenth one outbids you all by figuring for cheap work. Careful and conscientious insurance inspection brings him up to the rack, or shuts him out, and we all profit thereby.

The question of insulation was referred to in a pointed and timely manner by our friend Haskins, a year ago, and his suggestions seem to have taken root in the east. Insulated wire is now the rule, rather than the exception, in those places where insulation is most needed, and painted wire has "lost its grip." The difference in cost is too slight, and in point of efficiency and economy too great, to allow the reform to languish.

The location of central stations seems to be receiving merited attention, but not to that extent which the good of the profession demands. In the past, the practice has been to secure power, especially in the smaller places, where it could be had the cheapest, without regard to permanency and surroundings. The result has been that you have gone into cramped quarters, with hazardous occupations on all sides, above and below you. You have got power by using boilers already being worked well up to the limit of safety, or you have set other boilers in the limited space at your disposal.

There have been fires and losses charged to you which you might have escaped by locating more wisely, and as a consequence too many insurance men now look upon the electric light station as one of the specially hazardous risks.

Locate by yourselves as much as possible; build after modern fashions; do not spare brick walls and cement floors where they will add to your safety, and then you will get lower rates from stock fire insurance companies, or our "mutual" friend, Woodbury, will provide for you.

There are in New England, as many of you are aware, a dozen or more good, strong mutual fire insurance companies, known as the "Manufacturers' Mutuals." They confine their acceptances of risks to the largest and best manufacturing properties in New England and the Middle States, and, to a limited extent, in the Southern States and Dominion of Canada. Mr. C. J. H. Woodbury is one of the vice-presidents of the largest of these mutual companies, and the rec-

ognized expert authority for them all. About five hundred of the large manufactories insured by them are lighted by electricity, either arc or incandescent, and very largely isolated plants. They have received the inspection of Mr. Woodbury, and the greater part of those in New England, that of Inspector Brophy, also. I take pleasure in quoting from a letter on the subject recently received by me from Mr. Woodbury. He says:

"When electric lighting was first introduced, it was the cause of a great many fires, there having been twenty-three fires from this source in the sixty-one mills using it in 1881 and 1882. By April, 1882, all the electric lighting plants in property which was insured by the Mutuals has been changed to conform to the rules for installation which I had prepared in December of the previous year, and since that time we have not had a single fire from electric illumination. I do not know of any fires caused by electric lights which did not owe their origin to a disregard of principles laid down in those rules as essential for safety."

I think that statement bears me out in my assumption as to the almost entire immunity from fires due to artificial lighting that is attainable by the use of your methods, and I ask no better support.

Mr. Ridlon has advanced some excellent ideas looking to better work, in point of safety, in construction and maintenance,—that of examination for fitness and qualification, of the men who do this work, and the granting of certificates to them if found competent,—the same as is done in the case of steam engineers.

He would have the Board of Examiners composed of electrical and insurance experts. My only criticism is that his ideas fall short of the whole necessities. The absolutely impartial Inspector is still needed to see that the "tenth man," of whom I have previously spoken, does not prosecute his nefarious work without a certificate; also to see that those who hold certificates are not intrusting their work to cheap men who don't hold them, or that the guileless trimmer is not falling into the habit of leaving the bottom off his arc lamps.

I would not occupy your time with technical suggestions, if, indeed, I had any to offer, because they had better be left to printed rules and Inspectors; but it may interest you to know to what extent your business has prospered in New England.

The following figures are taken from our Inspection Records, and are probably about right. They are inclusive of Boston but exclusive of New Hampshire. For comparative purposes, I give them as they stood at the beginning of 1886 and also 1888.

NUMBER OF ARC LIGHT CENTRAL STATIONS.

In Massachusetts,	1886,	26	1888,	45
" Rhode Island,	"	5	"	8
" Connecticut,	"	9	"	21
" Maine,	"	4	"	14
" Vermont,	"	none	"	5
Totals,		44		93

Increase of 1888 over 1886, 111 per cent.

CAPACITY OF ABOVE IN ARC LAMPS.

In Massachusetts, [Including 2168 in ston in 1886 and 75 in 1888.]	1886,	3693	1888,	7305
In Rhode Island,	"	831	"	1961
" Connecticut,	"	782	"	3311
" Maine,	"	520	"	1465
" Vermont,	"	none	"	415
Totals,		5826		14,457

Increase of 1888 over 1886, 148 per cent.

JMBER OF INCANDESCENT LAMPS FROM CENTRAL STATIONS.

In Massachusetts, [Including 9000 in oston in 1888.]	1886,	8600	1888,	74,500
In Rhode Island,	"	600	"	2200
" Connecticut,	"	none	"	11,050
" Maine,	"	400	"	8100
" Vermont,	"	none	"	1400
Totals,		9600		97,250

Increase or 1888 over 1886, 913 per cent.

NUMBER OF ARC LAMPS IN ISOLATED PLANTS.

In Massachusetts,	1886,	459	1888,	721
" Rhode Island,	"	416	"	731
" Connecticut,	"	223	"	332
" Maine,	"	10	"	50
" Vermont,	"	58	"	128
Totals,		1166		1962

Increase, 1888 over 1886, 68 per cent.

NUMBER OF INCANDESCENT LAMPS IN ISOLATED PLANTS

In Massachusetts,	1886,	16,003	1888,	40,619
" Rhode Island,	"	4140	"	9546
" Connecticut,	"	2117	"	11,050
" Maine,	"	1860	"	6908
" Vermont,	"	none	"	475
Totals,		24,120		68,598

Increase, 1888 over 1886, 184 per cent.

Total Arc Lamps, 1886, 6992, 1888, 16,419. Increase, 1888 over 1886, 135 per cent.

Total Incandescent Lamps, 1886, 33720, 1888, 165,848. Increase, 1888 over 1886, 392 per cent.

Total Arc and Incandescent, 1886, 40,712, 1888, 182,267. Increase, 1888 over 1886, 348 per cent.

Those of you who may know the ratio of increase in other sections of the country for the corresponding period, can judge if New England insurance supervision is a detriment to your business, or otherwise.

A whole year without any considerable fire loss in our country from electric lighting, would be a splendid record, but none too good for any of us to contemplate.

While such a result is far outside the bounds of probability, in the present condition of things, it is well inside the bounds of possibility. As well might we hope to revolve the earth from east to west as to hope for anything short of millions of dollars of fire loss annually from the old methods of illuminating by combustion,—the candle, the gas and the kerosene oil flame, and the accompanying friction match.

S. E. BARTON.

THE VICE-PRESIDENT: Gentlemen you have heard e paper of Mr. Barton. It is now open for discussion.

MR. BARTON: I think the showing in New England ust be so good that there is nothing to say. It speaks r itself.

THE VICE-PRESIDENT: If there is no objection the aper will be received and spread upon the minutes nd the topic passed.

We will now hear from Mr. G. W. Parker of St. ouis on what constitutes a good carbon point.

Mr. Parker read his paper.

WHAT CONSTITUTES A GOOD CARBON POINT.

From the standpoint of the manufacturer all well aked carbons that are straight, free from cracks and ther similar defects, and made from pure material, are ood carbons.

The electric light engineer will say that no carbon is ood unless it will center properly and give him a easonably long life with a good light. He is not at all nquisitive as to the method of their manufacture, pro- ided they give such results.

But as the manufacturer can go no further than to orrect any errors in his mechanical processes, the alue of the carbon afterwards depends upon the con- itions of its use. Such carbons as are described in the rst paragraph will in some currents be satisfactory oth as to light and life. In others the light may be rilliant and the life too short, or there may be arcs too hort or too long, flaming or other defects arising from he unsuitability of the carbon to the current, there eing no inherent defect in the pencil itself. Therefore,

to cover the whole ground of this important inquiry, we should also have the carefully compiled statements of your experience of the behavior of carbons burning in your lamps under varying circumstances. From this, results of great value to both sides might be obtained.

There appears to be no trouble in determining what constitutes a good carbon mechanically, but to you a good carbon means one that will give you satisfactory results in your use of it, and there we find several difficulties, without taking into account imperfections in your apparatus. The first is the difference in the strength of the current used in the different systems, and, also, in many cases in different plants of the same system, the corresponding differences in the resistance of each lamp, and frequently, unequal adjustments of lamps in the same plant.

For convenience we are in the habit of referring to those systems in which a small current and a long arc are used as high tension systems, and those in which a large current and short arc are used as low tension systems.

The requirements of the low tension seems to be a carbon that is hard, well plated and a good conductor, the latter being the most important.

In the high tension, on the contrary, hardness and conductivity seem to be of secondary importance. There is a tendency to flame and burn unsteadily when a hard carbon is used in these systems and a softer one sometimes becomes necessary, which in many cases shortens the time in which a lamp will burn without being re-trimmed, but, in such case the difference is

fully made up in the brilliancy of the light. On the other hand, where a soft carbon is burned in a low tension current, the tendency is to form needle points which prevents the carbon from centering properly, causes them to heat and is apt to burn the holder.

Let us pursue the inquiry touching the questions of size, conductivity, mortality and light, and ascertain if definite relations can be established in regard to them that may result in guiding us to the selection of perfect carbons for use from a mass of mechanically good carbons.

DIAMETERS.

It is a matter of great interest to know in what manner and to what extent the size of the carbon effects the result in a current of given strength covering, of course, in the general question of conductivity, the all-important results of light and life.

HARDNESS OR CONDUCTIVITY.

It is well known that a hard carbon offers less resistance to the current, or, in other words, has greater conductivity than a soft one; therefore, in carbons of the same length and diameter, made of the same material, by the same process, conductivity increases and diminishes respectively with their hardness and softness.

In either hard or soft carbons whatever of conductivity they possess respectively will be increased or diminished, as the square of their diameters are increased or diminished, the length being maintained. It would appear, therefore, that it is possible to make a softer

carbon of larger diameter that will be the equivalent, in conductivity, of a harder carbon of smaller diameter.

MORTALITY OF CARBONS.

Of carbons of the same *hardness* and length, but having different diameters, the larger will, undoubtedly, outlive the smaller. Of carbons of the same *diameter* and length, but differing in hardness, the harder will outlive the softer.

Therefore, a carbon of larger diameter, which is soft, may be equivalent to a smaller carbon which is hard, as to life, just as it has been shown to be equivalent in conductivity.

The life of a carbon is, of course, dependent upon many vicissitudes, such as high winds, broken globes, etc.; but under the same conditions the statement made above is, undoubtedly, a fact.

BRILLIANCY OF LIGHT.

It is well known and admitted that as between hard and soft carbons of the same diameter the latter will give a more brilliant light.

It is just as well known that in case of hard carbons those of smaller diameter will, within certain limits, give a more brilliant light than those of a larger diameter.

On the above statement of facts it may be regarded as settled then that with the same diameter, but differing in hardiness, the hard carbon will possess greater conductivity and have a longer life, but with less brilliancy of light; while the softer carbon will have

ess conductivity and shorter life, with a more brilliant light.

And, further, that with uniform hardness, but differing in diameter, the larger diameter will have the greater conductivity and longer life, with a less brilliant light; while the smaller diameter will have less conductivity and a shorter life, with a more brilliant light.

The foregoing statements indicate invariably that with greater conductivity light diminishes and life increases; and, conversely, that with diminished conductivity the brilliancy of the light is increased and the life shortened.

In corroboration of this it appears that a small, hard carbon is, practically, the equivalent of a larger, soft carbon their conductivity being also equivalent.

Heretofore, it has been considered probable that the diameter, candle power, resistance per lamp, conductivity of the carbon point, and strength of current, are all interdependent, and a change in any of them will effect all the others, requiring a counteracting change or adjustment in some of them, in order to restore the proper relations between them.

This, if so, you can readily see is difficult to do; for part of the work is to be done by the manufacturer, and the remainder is under your control.

On the other hand, if the deduction can be properly made from the statements herein presented, that the resistance of the carbon point will determine its capability in respect to light and life in the different currents, the trouble is, practically removed. It is not impossible, I think, to construct a machine that will, at no great increase of cost, assort the carbons into groups

of uniform resistance or conductivity. Then, with constant currents, clean lamps, perfect connections, and insulation, you will ascertain practically that carbons mechanically good will prove to be good and uniformly so in actual service.

Much more could be written upon this interesting question, but this paper is already too long. I have noted for your discussion some important points which I hope your experience will enable you to determine definitely if they are well taken or not. I would be glad to have the whole question of the imperfect burning of carbon points thoroughly canvassed, so that manufacturers would get some hints as to what may be done by them in the way of correction when the fault lies at their door. It is especially desirable to be informed if that very disagreeable feature in the burning of carbons called "flaming" is always the effect of one particular cause and what that cause is.

G. W. PARKER.

MR. PARKER: I would like to say to the convention that the points presented in this paper are very important to manufacturers of carbons. If they are well taken, the road seems to be open to the manufacturer of carbon that will be uniformly good. Mr. Morrison stated to me that probably the best plan would be to have this paper printed and laid on the desk of each member so that a discussion may be had upon it tomorrow. I can readily see that the intricate points presented here cannot be understood by a simple reading, and if it is the pleasure of the convention this

course will be pursued. I am having the paper printed. What I have read from is a proof.

THE VICE-PRESIDENT: What disposition will you make of this paper?

MR. DUNCAN: I move, sir, that the paper be received as it is, and the gentleman's request be complied with and that a time be fixed tomorrow afternoon for discussion.

The motion was carried.

MR. DUNCAN: I move you, Mr. Chairman, that after the announcements have been made for tomorrow's program that this association adjourn to 9.30 tomorrow morning.

THE PRESIDENT: The program for tomorrow morning will first be reports from special committees, in regard to the nomination of officers for the following term etc., and that will be followed by papers by the following named gentlemen: One on alternating currents by T. C. Smith of Pittsburgh; and one on energy of alternating currents by O. B. Shallenberger of Pittsburgh; underground conduits by J. N. Smith of Detroit; underground conduits by W. W. Leggett of Detroit. These are very important questions; we are all widely interested in them and it is hoped that we will have a full attendance promptly at the hour named by the gentleman in his motion.

Mr. Duncan's motion to adjourn until 9.30 A. M. tomorrow was then put and carried.

PROCEEDINGS OF FEBRUARY 23RD.

The Association met at 10 A. M., pursuant to adjournment.

THE PRESIDENT: The first business is, by special order, the amendment to the Constitution, which the Secretary will read.

The Secretary (reading),

Resolved, That Article IV. of the Constitution be hereby amended to read as follows:

The President and Vice-Presidents shall be elected by ballot to serve during the following meeting.

The Treasurer and Secretary who may be one and the same person, shall be nominated by the President subject to the approval of the Executive Committee.

The Executive Committee shall be chosen by ballot at each meeting, either annual, semi-annual or special, to hold office from the close of the meeting at which they are elected until the end of the meeting at which their successors are chosen.

MR. DE('AMP: I move that that amendment be laid on the table.

MR. RIDLON: I hope that it will not be laid upon the table as there are many reasons why it should be acted upon. The convention is liable to be held in different places, in different parts of the country, and it is very desirable that all the officers of the convention, or at least as many as possible, and more especially the President, who would probably be a prominent local man in the locality where the convention should be held, should preside over the convention when it is held in his place. We have a very large number of men who are eligible for the office of President; although

perhaps none of them can fill Mr. Morrison's place. But, still, when we go outside of Mr. Morrison, we have a large number that we can select from; and it would take some little time to go around through them. I hope that you will act on this measure and not lay it upon the table.

THE PRESIDENT: This is a very important matter and I hope you will not call for the question until the members of the convention have all had a chance to speak, if they desire.

MR. LEGGETT: It seems to me that the action of the committee is in a proper line. At the Boston convention the same recommendation was made, but was laid upon the table. There is one suggestion that I would make in the nature of an amendment, and that is that the office of President shall be for one year, or at least until the annual meeting next succeeding; and that the Executive Committee shall be chosen to serve at each meeting. We have found here in this meeting the value of having the Chairman of the Executive Committee at Pittsburgh; and you will find in each place great value in having the Chairman of the Executive Committee at the place where the meeting is to be held. There is a great deal of work for the Executive Committee to do, and a great deal more work thrown upon the members of it who are at the place where the meeting is to be held, than upon any other parties. If the Chairman of the Executive Committee is selected from a place distant from the point where the meeting is to be held, it becomes a matter of very serious consideration as to what arrangements may be made for the entertainment of the committee, or for its

operations. On the general question of the selection of the President and Vice-President of the Association it seems to me it would be of great value to the Association to have the positions of President and Vice-President located about through the Association, so that all sections would feel interested in them. I think that there is nobody but would feel flattered and gratified to be selected to hold either one of those offices in this Association; and to confine their selection to the locality where the meeting is to be held will make such a limitation as to leave out of consideration some parties who ought to be considered in that connection, and who come from regions where perhaps the meetings of the Association would never be held. I therefore move, as an amendment, that the term of office of the President and Vice-President extend from the close of the meeting at which the appointment is made until the close of the next annual meeting. I hope the action of the committee will be considered and adopted and not laid upon the table.

THE PRESIDENT: You have heard the amendment, what disposition will you make of it?

MR. MASON: May we hear again the original motion with the amendment? Perhaps there are some here that did not hear the original resolution.

The amendment as reported by the committee, and amendment offered by Mr. Leggett were read by the Secretary.

MR. WEEKS: That is precisely the way our Constitution and By-Laws now stand. As I understand it the purpose of this amendment was to strengthen the hands of local parties in preparing and carrying out the

objects of the Association, and it was thought that if the President were chosen from the district where the next convention is to be held, that by virtue of his being the President of the National Electric Light Association he would be able to accomplish a great deal more for the Association in the convention over which he was to preside, than possibly would be accomplished by the Chairman of an Executive Committee. That I believe was the main idea of the parties who suggested this amendment. It was further suggested by our President and others that the time will very soon come when we will not meet semi-annually but annually. During the early history of the Association the developments in electric lighting have been so rapid that it has been an absolute necessity to meet semi-annually in order to keep pace with such developments; but our industry is becoming more and more nearly perfect every day; and the probabilities are that within a very short time an annual meeting will suffice.

MR. LEGGETT: I neglected in my amendment, to put the tail on, and I will add it now. I want to add this clause at the end of my amendment: "and shall not be eligible for election to the office for two successive terms."

MR. WEEKS: I might say that this matter was suggested, not by me, but by others, with a view of carrying out certain suggestions that I had made with regard to holding a convention in the West. It had from time to time been brought to my attention that the Association would like to receive an invitation from us in Kansas City to come out there and hold a convention. I had

always answered that we had not at present sufficiently ample facilities in the way of hotel accommodations to meet the convenience of the Association; but as I have stated to some of you personally, we are now constructing two very fine hotels; and they will have a capacity of about 300 rooms. They will be first class in all respects, and will be finished this next fall. I have suggested that our next annual convention be held in Kansas City. My reasons, and the reasons of others who have talked in this same direction, were simply these: On looking over our roll of members one cannot fail to be struck by the lack of western representatives. While in the West we have hundreds of plants—nearly every city and town in Missouri, Illinois, Kansas, Nebraska and Colorado being provided with electric light plants—still they have not sent delegates to our convention; and on speaking to them personally about it I could not induce them to do so on account of the great expense of time and money necessary to come east to attend a meeting of the Association. Now, it has been thought that by holding a convention in Kansas City if wisely advertised for a while, we might bring in all these elements. It was with a view of carrying that matter out that this amendment was suggested. It was, as I understood it, with a view of selecting somebody in that locality for President of the Association who could accomplish the most for the Association in carrying out this matter.

MR. PHELPS: From the discussion of this topic, or of topics allied to it at the previous meeting, I infer that there may be a suggestion, or an objection in the minds of some to this very rapid change of officers, on

account of there being danger of some lack of continuity in the work of the Association—something omitted in the work as between one meeting and another; but it seems to me that that objection will still be met if any one still entertains it, by the provision which I understand is to be made for a permanent Secretary under compensation, who will be in a position to preserve the continuity of the work, and by keeping upon the Executive Committee a certain number of gentlemen from time to time, so that that committee, having charge chiefly of the work of the Association, will be in a position to preserve this continuity and relation between the business of one session and that of the next. It seems to me therefore that the suggestion embodied in this amendment to secure a President, Vice-President and chairman of the Executive Committee from the vicinity in which the meetings are to be held is eminently desirable.

MR. MASON: May I ask if this is proposed as an amendment to the Constitution under which we are now acting?

THE PRESIDENT: Yes.

MR. MASON: Article IX. reads that: "All amendments to the Constitution shall be presented in writing and referred to a committee to be appointed by the Chair before being acted upon by the Association." This amendment is presented here in writing. Now, it seems to me that perhaps we shall be better prepared to act upon this matter if we take time—if we shall take a considerable time. As I understand Article IX of the Constitution we are not prepared to act upon this amendment until it shall have been referred to a committee

to be appointed by the Chair, and a report had back from them. Am I right in that?

THE PRESIDENT: Was there not a committee appointed on this yesterday?

MR. WEEKS: No. The gentleman's point is well taken.

MR. RORISON: I move that the whole matter be laid upon the table.

MR. MASON: I believe that I have the floor, and I had a motion to make after the ruling of the chair is made.

THE PRESIDENT: The chair decides that the point of order is well taken; and it is not now in order to discuss this matter. If the gentleman will now offer his amendment I will appoint a committee; the amendment can be referred to the committee and they can report at this meeting.

MR. MASON: Then I will make this motion which I think will commend itself to all the members of this Association: that this matter be laid upon the table until the next session of the Association.

MR. LEGGETT: I think that that had better not be done.

THE PRESIDENT: A motion has been made and seconded that this matter be laid upon the table, and made the special order for the next meeting of the Association. A motion to lay upon the table is not debatable; but, with the consent of the convention, Mr. Leggett will be permitted to proceed. There being no objection, Mr. Leggett has the floor.

MR. LEGGETT: I hope that this will not be done. This is a matter, which, although formally submitted to

the committee, has been considered by the committee at this session. And this committee have considered it very fully and have made their report. It has been done evidently informally, according to the point of order raised by Mr. Mason and ruled upon. Now it seems to me that it should be referred back to this committee. Now the motion which Mr. Weeks has been requested to make will be in order, that the committee consider the matter and that they report to this convention.

THE PRESIDENT: The matter having been decided out of order, the discussion is out of order, and there is nothing before the convention at the present time.

MR. LEGGETT: Is it in order to lay the motion on the table?

THE PRESIDENT: There is nothing before the meeting at the present time.

MR. LEGGETT: Then I move that we take this up. Now you see the necessity of the suggestion which was made the other day; and if it had not been that I corrected the impression that I am not Dr. Leggett, but Mr. Leggett, that would probably have been credited to me. I now offer the motion that his matter be referred to a committee to be appointed by the chair to consider and report back at this meeting.

THE PRESIDENT: But there is no matter before the Convention at present. I would suggest to you that you offer as an amendment the subject-matter of your amendment to the matter which was before the Convention this morning, and which we then believed to be in order. I was not in the chair last evening, and have not kept the run of the proceedings of the

Convention. I suggest that you make your own amendment now as an amendment to the Constitution, and let it come originally before the Convention.

MR. LEGGETT: Then, Mr. President, I make the motion that Article IV of the Constitution be amended by adding at the end of the first clause, after the word "meeting," the following words: "and shall not be eligible for re-election for a next succeeding term." Then the Article will read: "The President and Vice-Presidents shall be elected by ballot to serve from the close of the annual meeting at which they are elected until the close of the next annual meeting, and shall not be eligible for re-election for a next succeeding term."

THE PRESIDENT: You have heard the amendment to the Constitution offered by Mr. Leggett. Under the provisions of article IX this amendment goes to a committee to be appointed by the chair. I will name as such committee Mr. Leggett, Mr. Weeks and Mr. Duncan; and I instruct them to report at this meeting. The next thing in order will be the report of the committee for nominations for officers, but, in view of the action just had, I would suggest that the reading of that report be postponed until after the report of the committee just appointed. If there be no objection expressed it will be so ordered.

MR. DECAMP: I would like to ask if the duties of the committee just appointed to consider Mr. Leggett's amendment are confined to that particular amendment. In the report of the Executive Committee I think that there was a provision made for making the position of Secretary and Treasurer a salaried one. That is not

provided for in the Constitution, as it seems to me it ought to be; and I think that will require an amendment to the Constitution. I think it ought to be acted upon at this session, and if you will give me time I will frame an amendment and it can go to the same committee.

THE PRESIDENT: You can have the floor for the amendment at any time you may wish. Then it can be referred to the same committee. Before proceeding to the regular order of business Mr. T. Carpenter Smith of Pittsburgh, desires to make an announcement.

MR. SMITH: I have much pleasure in announcing to the members of the Convention that we have made an arrangement with the officers of the Philadelphia Gas Company, through Mr. Westinghouse, to have their stand-pipe at 36th Street lit at seven o'clock this evening; and members who have not seen it will find it of interest. I may say that it is equivalent to the lighting of one of the regular gas wells. For those who wish to visit it the cars will be in waiting at the hotel at 6.30. Those who wish to see the performance are requested to come promptly as the heat from the pipe is so tremendous that it hurts the roofs of the houses in the vicinity, and they do not care to keep it lighted for but a few minutes at a time. Those who go will be able to return in time to take the eight o'clock train for the east.

DR. MOSES: It is perhaps out of order, but just suspend your judgment for a while to enable me to offer a recommendation to the committees that has been appointed by the chair. A committee is supposed to express the feeling of the body from which they are

severed for the time. It is rather a concentration of action for the purpose of subsequent general discussion. I would therefore ask these gentlemen of the committee who have been appointed to consider the amendment of Mr. Leggett, to bear in mind that we have been going along successfully since the founding of this Association under one leadership. (Applause.) If we have been successful it is very largely due to his discretion, and to his continuous government of this body. He now finds the burden a little unbearable at present, and has got restive; and, if I may use such an expression, he has "kicked over the traces" this time. But, we may still want him as a wheel horse; there is no telling. Therefore, I would ask that committee to please consider seriously whether it is advisable in any way to hamper us in our re-election of such a man when the time may come that it shall seem desirable. Death might remove the most able presiding officer; circumstances might cause his resignation; we might feel as if there was a kind of crisis in out affairs; and it would not be possible perhaps to amend the Constitution quickly enough; and it may be necessary for us to have the leadership of our President again. Therefore, without anything that appears like fulsome compliment, or that bears any appearance of flattery, (for I regard that as once "sat upon" by the committee) I think it would be wise to consider very carefully whether we should hamper ourselves at any time when we get a good man in the office,—a man who might be preeminent in that position, and whom we should not want to get rid of. Another crisis may occur in the history of the Association. The very legislative pool that the

Chairman of our Legal Committee was going to stir up might require us to have a very strong man in the chair. So I hope that the committee will consider this suggestion, and will excuse my offering it.

I am requested, Mr. President, by E. G. Acheson, the gentleman who was appointed yesterday by the chair as a member of the Committee on Insulation, to express his thanks to the Convention for the honor done him, and to say that he feels that while he is perfectly willing to give us the benefit of his experience in such matters, still the fact of his occupying a position on that committee might be misinterpreted by other gentlemen who are connected like himself with wiring interests. And, therefore, while thanking the Association for its action, he respectfutly declines the honor of the appointment.

MR. MASON: I move that we accept the resignation of Mr Acheson. I make this motion, as I made the motion yesterday confirming the action appointing him; and I do it in deference to his delicate feeling, which I fully appreciate.

THE PRESIDENT: Ordinarily the appointment of a gentleman upon any committee would be directly in the hands of the President; and the necessity for a resignation would not exist. Mr Acheson was paid the high compliment of having been elected to a place on this committee by the direct and unanimous vote of the National Electric Light Association; and that is a compliment which was never before paid to any gentleman in the history of the Association. It is with the deepest regret (you will excuse me for speaking from the chair, but that was one of the rights I reserved to myself when you made me President in Chicago) that I find

that the Association is now about to lose (because I see the drift of this) the services of a man so eminently capable of acting on that committee, and of giving intelligent and useful information to this Association. I hope, although he leaves the committee, he will not deprive us of those services which he is so eminently fitted to give. The question is on accepting the resignation of Mr. Acheson.

(The question was put, and the resignation accepted.)

THE PRESIDENT: I suggested to the acting President of yesterday afternoon the propriety of having the very important papers which were to be read, presented for discussion this morning. I did not expect to be here till late this morning; and I expected that Mr. Weeks would occupy the chair, and attend to all this preliminary business. I am glad now that the discussion has not taken place this morning, as our time is somewhat limited. We are now through with our business, and are ready for the discussion. The papers to be read relate to a subject of more interest perhaps to the members of the Association than any subject that has been presented to them for a long time,—that is, they relate to the alternating and direct currents. Mr. T. C. Smith of Pittsburgh, and Mr. Shallenberger of Pittsburgh, are to present their view of the case from the alternating current side; and Mr. Leggett and Mr. Jesse M. Smith of Detroit are to present the other side. The other side covers a whole lot of ground. If there be no objection all of these papers will be read one after the other, and then the discussion can take place intelligently, as you will then have both sides of the question before you.

If there is no objection expressed the papers will take that course of procedure.

THE DISTRIBUTION OF ELECTRICITY BY ALTERNATE CURRENTS.

The distribution of electricity by means of Alternating Currents, though comparatively new in this country, has already reached such an enormous importance that it is with great hesitation that I venture to speak upon it, even though limiting myself to the strictly practical side of the work, dealing only with the apparatus as we receive it from the hands of the manufacturer, and leaving out entirely the question of the efficiency of dynamos and converters. It is only the knowledge that the mistakes of those who enter upon any new line of business are the rounds of the ladder by which we all attain success, that emboldens me to lay before you some of the conclusions at which I have arrived after several years' experience of various types of electric lighting, both by the arc, by the direct current incandescent, and the alternate current incandescent.

The subject naturally divides itself into several heads, but I would first say that it appears impossible to lay down any general plan of distribution which shall be practicable in all cases. In almost every town a different plan will be required, and this will depend in most cases purely upon local circumstances. Systems and methods that would be admirable for thickly-settled and densely-populated districts will not be successful in thinly-populated and widely-scattered ones. I wish it to be understood that whenever I speak in this paper

of success and successful systems, I mean successful entirely in a commercial way, and the conditions of this commercial success will vary in every town and district. I will therefore content myself with describing the method which I have found to be most successful in the various districts with which I have had actual experience, and leave it for those who may be called on to design and lay out the lighting of any particular district to judge for themselves which line of action to pursue.

Naturally the first part of my subject is the dynamo, and the station detail. I have tried the small and large dynamo, and have concluded that it is a very great point to properly proportion the unit size of dynamo to the probable size of the station; that is, not to have dynamos of different sizes, but to first determine what the unit shall be, making it as large as possible, and then make your whole apparatus additions to that unit size. This simplifies matters very much, enabling machines to be interchangeable, both as regards their parts and their work, and this I am sure will be admitted by all who have ever had the annoyance of a breakdown on engine or machinery when perhaps they had standing idle plenty of apparatus, which, from various circumstances, could neither be used itself, nor be robbed to repair the breakdown.

I would drive each dynamo by a separate engine, and this for several reasons; by proportioning the engine to the dynamo, it will be possible to have the engine running slightly overloaded when the dynamo is doing its utmost during the hours of heavy lighting, and as this extreme load falls off to the lighter hours of running,

the engine will be working at its point of best economy, instead of running underloaded, and thereby wasting steam. Thus we use in our station on Virgin Alley dynamos of 2500 lights capacity each, driven by 200 horse-power engines. During sixteen hours of the day these dynamos run driving 2000 lights, and the engines are cutting off at quarter stroke, and developing 200 horse-power. During the other eight hours, we have driven these dynamos as high as 2800 lights, during which time the engine was of course overloaded, and not working to so good an economy, but eight hours of overload is not nearly so wasteful as sixteen hours of underload; again, we have had it very forcibly demonstrated more than once that if the engine be only large enough to drive the dynamo with ease, a heavy short circuit on the mains outside will simply pull the engine up or slow it down, without destroying the dynamo, and only those who have seen a nine-foot fly-wheel running at 250 revolutions per minute on a 200 horse-power engine, slowed right down in almost an instant of time, can realize the terrific strain to which everything is subjected in such cases, and I would mention right here that the element of time is a great factor in such circumstances, as in an accident of this kind mischief is often done before the safety catches can melt out. The direct belting of the engine to the dynamo is always to be preferred; shafting is, except under exceptional circumstances, simply a nuisance for incandescent electric light stations, and the economy of one large engine over many small ones has been enormously overrated. For arc light work, where the lights are all lit and extinguished at certain hours, the large engine

is good; but for incandescent work, where the load is absolutely out of the control of the station, it is impossible to steadily run a large engine at anything like its most economical load, whereas with separate engines the machines can be started and stopped the moment that they are needed or are done with, while the oil from shafting will always cause more or less grease and dirt.

For Central Station use, except for very small plants, I should certainly use separately-excited dynamos, and should do the exciting from two or more dynamos, each capable of exciting the whole system. In this way, with the station running at its normal, the only regulation required is that obtained by working the single rheostat in the field of the exciter, and, as we have designed our station at Pittsburgh, this will mean the regulation of 15,000 lights by one six-inch hand-wheel. Of course each dynamo should have its separate field rheostat to make up for any slight difference in speed of engines. The two exciters should be so arranged that they can be run together or separate, or that either can do the whole work, which of course is easily accomplished by feeding them into a separate pair of exciter bars on the switch board, and charging the fields of the alternating dynamos from these. The general question as to whether it is better to use separate circuits for separate machines, or to couple them into a general set of 'bus wires, and distribute from them, is too large to be lightly decided, as also is the question as to whether it is best to run separate circuits for separate districts or to run into a general system of high pressure mains outside of the station,

feeding into these mains at different points, and again distributing from them, and I am not prepared to express any preference, but think that local circumstances will generally decide this question. There seems to me little doubt that in underground systems the net work of high pressure mains would be the best, but for overhead work we have adopted the system of separate circuits from separate dynamos, using a switch-board which enables us practically to run any circuit or any number of circuits from any dynamo, and running these dynamos separately and not in multiple arc. In spite of the utmost precautions, the unregenerate telephone and telegraph men are always hauling wires across our high pressure mains and feeders, and while their wires and not ours generally suffer, after hearing the frightful roar that comes from the dynamo which is running the particular circuit so crossed, we always feel relieved to know that only one dynamo is in danger of being thrown out by the slipping off of the belt, and a twenty-inch belt is not a pleasant thing to have flying around loose. In case of any trouble, such as fire, circuit broken down, or anything of that sort, we can pull the switch of that particular circuit, until we can cut out the part affected. The system that I have laid out for use here will of course take a long time to introduce, in view of the fact that we are changing from one system to the other, and have to be governed largely by the location of our lighting, our existing lines, and the possibility of putting up additional pole lines, but it takes in my vision the form of a series of heavy mains down the main streets with cross lines on the cross streets, with switches on the poles enabling any of the cross

streets to be run from the mains on either of the main streets, so that in case of a fire on one of the main streets, the section represented by the block in which the fire occurs, can by the pulling of two switches be completely cut off, while the cross streets on either side of the section will enable the lights beyond the fire or broken circuit to be operated, with only the trouble of a slightly larger percentage of loss and the consequent dimming of the lights.

For the main overhead wires, I must harp upon the old string which cannot be struck too often; namely, high insulation. For 100 volt current work, the old standby of "Undertakers" wire will pass; but when it comes to 1000 volts difference of potential, and 130 or 140 amperes to back it up, one realizes very quickly that nothing is too good to curb this fiery steed. We are still paying the penalty of early ignorance in having many circuits of Underwriters wire stretched upon our poles, and I have stood and listened with fear and trembling to the howls of a new dynamo which had only been in operation for a few hours, when we had four short circuits in as many minutes, caused by dead wires falling across these mains on a wet day; while on the other hand I have been gratified beyond expression to see our linemen remove ten or twelve old bare iron "District-call" wires which had been hanging all night right across our high pressure high insulation mains, and this during a soaking rain. Especially should the service wires to the converters be of the best insulation, not only for fire, but for protection to life, for while the shock does not kill, even a 100 volt shock may make a man start so as to fall off a ladder,

and any death or injury will be credited to the electric current. We have adopted a standard of a separation of three feet between the two wires nearest each other on our cross-arms, and do not allow under any circumstances the tapping of service lines directly to these wires. All services must be attached through the medium of a small spreader on the end of the cross-arm, which I have no doubt all those present have noticed on the streets.

In some districts where the number of lights in each building is small, we run secondary low pressure mains, and place the converters on the poles, and make our distribution from our secondary mains, but our experience has been that this is not a very satisfactory way of doing. The percentage of loss on these secondary mains, unless the wires are very large or the converters very numerous, either of which is objectionable, causes such a decided variation in the lights as to give grounds for numerous complaints.

The question of the loss on the high-pressure feeders and mains is one which I think has not received enough attention. When the alternating system was first introduced, so much was said about the extreme smallness of the wire required that a great many of the arc light fiends throughout the country, who had been accustomed to congratulate themselves on the fact that No. 6 wire was big enough for a 20-mile circuit, immediately jumped to the conclusion that because it was a high-tension current, No. 6 wire was big enough for all cases; and consequently more than one case of dreadful grief has arisen. I have laid out our circuits on a certain fixed plan, which is that each circuit shall be laid

out for 1300 lights (that being the size of unit which we at first adopted) and made of such sizes as to carry these 1300 lights with a loss of not more than two per cent with the whole load on. By having feeders large enough for this, we prevent any noticeable difference in candle power from one end of the circuit to the other, and should we be even compelled to run a light circuit and a loaded one on the same machine, the increase in the one or the decrease in the other would not be injurious. Of course we try to so arrange our circuits that the load shall vary about the same on each, but the suddenness with which storms creep up in Pittsburgh makes our load very uncertain and erratic. We have run for three days and nights with only a little more than half of the machinery in operation, and then from Monday night to Friday morning have had to run every incandescent machine in the station under a load that fairly staggered it.

I now come to the question of the placing of the converters, and for this I think that you may safely lay down the general rule that wherever you are simply carrying current, do it at high pressure, and keep your low pressure for the purely local distribution. With proper precautions, I do not see that there is any real danger in carrying the high pressure wires into and through the building. If a thousand volt current from a central station is not to be allowed in a building on account of its dangers, then every arc light plant—whether from central station or an isolated plant in the building—must be condemned for the same reason. Of course, the cases where two wires of an arc circuit with a difference of potential of 1000 volts are run close to-

gether, are not nearly so many as must be the case where there is a constant difference of potential of 1000 volts in the alternating system, and again, of course we have the fact that the direct current on arc circuits is generally not more than 20 amperes, while as I have remarked before, our alternating circuits run as high as 130 amperes; but the fact that one is a direct, and the other an alternating current largely makes up for this difference. With all due respect for the many gentlemen who have discussed so learnedly on the deadly alternating current, and on the frightful results therefrom, and whose experience with the alternating system is mostly confined to the magneto bell or induction coil, I must maintain that the alternating current, while it is in mild doses of from one hundred to two or three hundred volts intensely more disagreeable than the direct current of the same voltage, when it comes to 1,000 volts or more it is very much less dangerous to life. I make this statement with the more confidence that I have tried them both, and we have in our station here not one but half a dozen cases where our linemen and dynamo men have received the full 1,000 volts, generally being pretty badly burned at the point of contact, but experiencing no ill after effects, while whenever any of our men receive a shock from one of our arc machines, they are nearly always sick for a day after. This very fact of the alternating current being more disagreeable adds to its safety, as the men are disinclined to work on the wires, even when there is only a slight leak, where with the direct current they will often take much greater risks. In carrying our high pressure

wires through the buildings, we have adopted the invariable rule that they must be carried on porcelain insulators, and the wires themselves waterproof, in all cases. We do not allow them to be run in moulding, but where the wires are to be concealed or protected a casing is run around the wires, outside of the porcelain insulators, giving them a perfect air insulation, and hard rubber must always be used for floors and walls. The converters are all placed with porcelain knobs behind them, giving an air space of two inches between them and the wall, and we prefer in all cases to put them against brick, rather than against wood or plaster. I understand that in some districts the use of converters inside buildings has been forbidden, but I think that this position is a most unjust and untenable one. The only argument that can be brought against their being placed inside is the danger to life or of fire. For the first, the converter is well insulated, and is placed high up out of reach, and most potent argument, though one I am sorry to say often refused recognition, it is not placed there to be handled. As regards the danger from fire, all the converters with which I have had any experience are boxed up completely in iron cases, the only opening in which is a small one at the bottom for ventilation. They cannot possibly get hotter than the melting point of lead for the simple reason that if they should the fuses would blow out and cut them out of the circuit, and any one who has performed the old experiment of melting lead in a piece of paper, can easily see that this heat is not liable to set anything on fire, and even should the converter burn out no flame can escape from it to set fire to anything however inflammable. If the

converter is to be banished from buildings on account of danger from fire, then every stove, every high pressure steam pipe, and for that matter every gas jet, must also be banished.

In a Chinese fire-cracker, lately published, I find the statement that Inspector McDevitt has relegated to the cellar all converters, and that he says that in the first case of explosion or fire from them, they will have to go to the street. Now, as Vice-President of the Company, owning these converters, I have simply to say that this is not so, and that the converters are placed all through the buildings, wherever we may desire to have them, and only three or four are in cellars. Moreover, so far from Mr McDevitt making any such statement, he has steadily refused even under the most urgent solicitation of the Chinese gentlemen, to make any such restriction, but has very properly stated that until an explosion or fire occurred, he can take no such action. I speak of the publication as a "fire-cracker" for three reasons,—first, because it is red; second, it is chiefly noise; thirdly, a good many crackers are only fizzles.

As regards the liability to burn out, and the dangers therefrom, I can only say that from over 600 converters of all sizes from 5 to 50 lights each, in an experience extending over twelve months, of constant service night and day without any stop, we have had but three actual cases of burning out, two of these being 5-light converters, and one being a 50-light converter. The two 5-light converters were simply slowly roasted out from overloading, until finally the insulation on the primaries was charred through, when the fuses blew out instantly, and all was over. In one case the customer had been

attracted by the converter singing, and was standing looking at it when his lights suddenly went out, and he had to go into a neighbor's store to know whether the trouble was in his lights only, or with the main circuit. The 50-light converter suffered in the same way, having nobly endeavored for some two days to run 120 lights. It was one of three on a section of secondary mains, and the lineman who had been sent out to examine them owing to a complaint to us of poor light, reported that two of them were all right, as they were cold, but that one of them was bad, as it was very hot, and preparations were being made to change this converter, when a message was received from one of our customers that the "stove on the pole" in front of his place was smoking. Investigation showed that both plugs in the other two converters were blown, and the only reason that this one had not followed suit was the fact that some ingenious gentleman had made them of copper. We have had three cases of defective converters; that is, converters with a wire broken inside, or short-circuited, so that the moment that the current was put into them, they would blow out all the fuses, and if new fuses were put in, they would again immediately blow, but the men in these cases of course immediately returned them to the shop for examination; that is to say, out of the 600 converters, we have actually had to remove or repair one per cent. in actual service, and I submit that on a total converter capacity of 17,000 lights, this is a very good proof that these converters are well made and not dangerous.

In all our experience, we have not had one single case of connection between the primary and secondary,

or the primary and the shell of the converter, even in the case of the burned-out converters, and we had just a few days ago the first case of a connection between the secondary and the shell of the converter, and this last was found upon examination to be due to careless connecting up by which the end of one of the "leading in" wires had been jammed against the iron shell.

We started in with the idea that it was better in cases where we had, from the number of the lights in a building, to use more than one converter, to bank them; that is to say, connect all the primaries and all the secondaries in multiple, and distribute from this 'bus wire, but two or three peculiar experiences have led us to change our plans, and never to do so if it can be easily avoided. We had two or three unfortunate cases where one converter of a bank for some unknown reason would blow its plugs, thus overloading the others, then perhaps another would give way, and thereafter it was a race as to which would blow its plugs the quickest. It is not calculated to make one feel comfortable to have 400 lights in a theater go out at once, just as the curtain was about four feet from the stage, in the beginning of the third act, yet this was our experience last Christmas day. We had the converters fused up and running in half an hour, but next day the same thing occurred, though the gas man seeing the lights dim down was quick enough in shutting off his different circuits to stop three or four converters, which gave him lights enough to pull through. We have cut this building up, and each converter now carries its own load, with the result of our detecting one of them which for some reason unknown always tried to do more than its share of the work, but

while we have marked it, we have not troubled to change it, as, working singly, it does its work well. We have had another case of the same kind in another bank of converters, which have also since been cut apart, when we found the trouble arose from a poor connection which heated up the fuse to melting point; yet, as we have in the City Hall two banks of 12–40 light converters each, and in the Union station a bank of 23–40 light converters and 8–20 light converters, which have never had the current off them for nearly three months, and have never had a single converter of all these blow its fuses, we cannot say that this result would always or even generally obtain; but as the object of banking is, primarily, to prevent the total extinction in case of one converter going out, and this is better attained by the judicious running of the secondary circuits, we prefer keeping the converters separated.

For the secondary wiring in the buildings, we need lay down no laws. For the rules governing this are too well known to need any repetition. One advantage of the alternating system, which was first brought to my attention by one of our wiremen, is the fact that wires carrying the alternating system do not blacken the surface on which they run. We have in our station circuits of direct and alternating currents side by side, put up at the same time, on a ceiling painted in very light colors, and which have been burning the same number of hours. The paint under the direct current wires is very dirty, in the usual style, and the wires themselves are covered with a black deposit, while the alternating current wires, and the ceiling on which they lie, are as clean as the day when they were put up.

There yet remains one point on which I wish to say a few words, and it is a subject of the greatest importance. Now that the alternating current distribution is a pronounced success, there is no reason why the places of all others where incandescent light is most desirable, namely in residences, should not enjoy the advantages and improvements from which they have hitherto been debarred by their distance from the usual centre of distribution, and it is when we bring electricity into the dwelling-house, where it will be daily and hourly needed and handled by women and children, that we realize how absolutely necessary it is that we use anything and everything which can tend to make safe its introduction and manipulation. Of course the first, second, and third of these are, good insulation, better insulation, and best insulation; but besides this, there are other points to be considered, and one that seems to me worthy of very careful consideration, and the fullest discussion, is that which has been more than once suggested; namely, the making of a permanent ground connection with the secondary wires. The object of this of course is, that should a leak occur at any point between the primary and the secondary, the current being already grounded will render it impossible for anyone to receive a shock by touching the secondary, and at the same time making an earth connection. When I first considered this question, I said in my haste that this was not a proper course of action, as one is simply provoking a ground at some other point, and seeing the careful insulation of the converters we use, I could not see any danger of a leak across; but I have since made up my mind not to come to any conclusion

at all until I have considered and heard some discussion both pro and con, and for this purpose I should like to have the most bitter partisan on either side, that we may get from them every little weakness on either side of the question brought out.

In a paper like this, it is impossible to do more than to give the merest sketch of the subject, but I trust that what I have said may be the means of inviting discussion and inquiry, for it is only by this means that we can arrive at the true facts of any case, and, as we all know, the Electric Light industry has suffered more than tongue can tell from the general ignorance of its dangers and requirements, which hindered and injured its early introduction into this country, which led to the spending of so much good money on plants and wires which were not merely insufficient, but absolutely dangerous.

Now that we have taken as it were a new departure, and entered upon a new era of progress, let us not fall into the same errors which marred the early history of our business, but strive with might and main, by discussion and interchange of experience, to make each new installation another stride towards perfection in what I think is undoubtedly the greatest Electric Light achievement of the age,—the Distribution of Electricity by Alternate Currents.

T. CARPENTER SMITH.

THE ENERGY OF ALTERNATING CURRENTS.

The adoption of the alternating current for electric lighting has introduced a number of questions in regard to its measurement which have an important practical bearing, since they involve the subject of the relative efficiency of the direct and alternating systems; and for this reason, perhaps, a few words on the subject may not be amiss.

It is not proposed to enter into a mathematical discussion, but rather to offer a few illustrations and examples which will assist in a general understanding of the subject, and at the same time prove the uncertainty of the well-known rules for direct currents, when generally applied to alternating currents. Under certain well-defined conditions such methods may be employed without sensible error, and fortunately for the electric lighting industry, these conditions are naturally present in the exact kind of apparatus necessary for the simple and economical distribution of the alternating current.

In estimating the amount of energy expended in a circuit traversed by a direct or continuous current, we are accustomed to base the calculation on measurements of the difference of potential between the two points of the circuit in question, and at the same time, the current traversing that circuit. The product of these two quantities, as is well known, gives a correct measure of the energy of the circuit expressed in watts. This method may or may not be applicable to alternating currents, the distinction depending upon the presence or absence of self-induction in the circuit. In

the case of a straight copper wire going out from the source of current and turned back on itself in close proximity, it may be assumed that self-induction is practically absent, and hence no sensible error would be involved in taking the product of the difference of potential between any two points, as measured on a Cardew volt meter, and the current traversing that portion of the circuit as determined by a Siemens dynamometer, and then using these two factors in the product which represent the amount of work done. This would give a correct result; but the introduction of a coil of wire wound in one dirction, especially when it surrounds an iron core, greatly modifies the conditions, and causes an error the amount of which is dependent on the form and size of the coil. The reason for this is that the additional element of self-induction has been introduced, with consequent retardation of the phases of current. This simply means that, as the difference of potential alternately rises and falls and reverses its polarity, the corresponding fluctuations of current do not occur at corresponding instants of time. The want of synchronism may be of any amount between zero and a quarter of a complete wave length. When there is no self-induction present in the circuit, there is no displacement, but a departure from this relative position may be produced by introducing self-induction into the circuit and to a point which may theoretically cause the waves of current to lag a quarter of one complete alternation behind the waves of the electromotive force, although it is impossible to realize this amount in practice.

Let us inquire now what is the effect of this displace-

ment on the amount of energy expended in the circuit; but as a preliminary step it will be well to examine the case of a secondary battery which is being charged from a suitable direct current generator. Suppose first, that current is supplied from the generator, with a sufficient electro-motive force to overcome the counter electro-motive force of the cells and produce a certain flow of current. We may introduce into the circuit a suitable ammeter to determine its amount, and connect across the circuit a volt meter, and by the product of the indications of these two instruments we obtain a result which shows the expenditure of energy at that time. But if, later in the process of charging, the speed of the generator is reduced to such a point that the counter electro-motive force of the battery is sufficient to overcome the eleetro motive force of the generator and cause a flow of current in the opposite direction, it is well understood that the battery would no longer be charging, but would be running the dynamo as a motor, and consequently expending energy upon it. If the resistances of the armature and battery are low, the readings of the volt meter and ammeter might be exactly the same as in the former case, and the product of these two factors would of course show the same amount of work done. In the absence of any other information than the readings of these instruments, it would be impossible to judge whether work was being done by the generator on the battery, or by the battery on the generator. Another element requires consideration, and that is the direction of the current as related to the difference of potential across the circuit. Referring to diagram 1, a generator is shown at G supplying current

to charge a battery at B. Let it be assumed that the electro-motive force of the generator is in such a direction as to make the upper conductor positive, with relation to the lower. Calling this a positive electro-motive force, a current in the direction of the full arrow

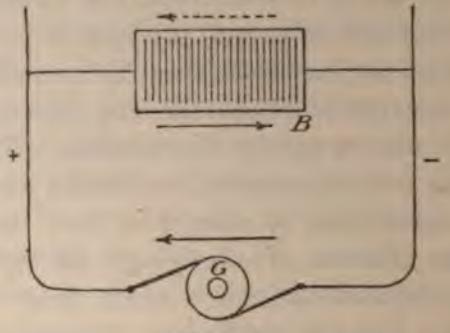


Figure 1.

would be positive, and one in the direction of the dotted arrow would be negative. Wherever the generator is doing work on the battery the current flows from the positive to the negative conductor through the battery, or in the direction in which the generator tends to deliver the current. If we had called the electro-motive force of the generator negative, this would be a negative current. We can assume either, but in each case the current and electro-motive force have the same sign. When, however, the electro-motive force of the generator falls sufficiently to allow that of the battery to overcome it and send a current in the opposite direction, as shown by the dotted arrow, the conditions are reversed; that is, the battery is doing work on the generator and driving it as a motor, but without the polarity of the external circuit being changed. We now have a positive electro-motive force, a negative

current in the battery, and work done by the battery on the rest of the circuit.

The foregoing is only an illustration of the general law that when the difference of potential between two points on an electrical circuit is of the same sign as the current traversing it, work is being expended in that portion of the circuit; and conversely, if they are of opposite signs, work is being restored by that part of the circuit. It is therefore necessary to know the relative polarities of the current and electro-motive force, as well as their amounts, in order to have a complete knowledge of the energy of a circuit. The same thing is true for an alternating current, that is, we must know whether the instantaneous values of electro-motive force and current have the same sign, as well as the values themselves; and this can only be the case where no self-induction is present, or in the practically equivalent case in which the self-induction is so nearly neutralized as to be of no relative importance.

Referring now to diagram 2, there are shown two curves in the upper figure, E and C. E represents the phase of the electro-motive force of an alternate generator, and C the corresponding current through a circuit possessing a certain amount of self-induction. Distances along the horizontal line are taken, as usual, to represent successive periods of time, and the relative amounts of current or electro-motive force are represented by the vertical distance above or below this line, those above being called positive, and those below negative. It will be seen on inspection of the figure, that at the instant shown at 1, the electro-motive force is zero, while at the same time the current has a con-

siderable negative value. Again at the point 2 the current falls to zero, while the electro-motive force has risen to the amount shown by the vertical line at 2. At 3 we have an instant at which the current and

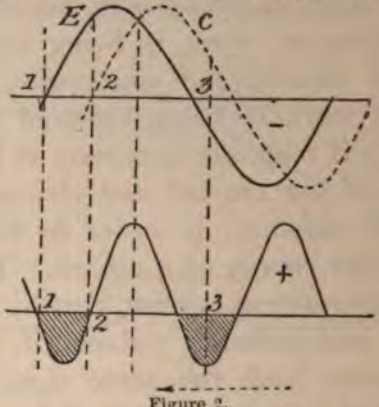


Figure 2.

electro-motive force are of opposite sign. Here we have three distinct cases, in the first two of which no work is being done, and in the third, work is being done by the circuit on the generator; but in each case an effect would be produced on the instruments used for the measurements of electro-motive force and current. In fact, taking independent continuous measurements of the electro-motive force and current, it is quite evident that the same results would be obtained without regard to the time relation of the phases, so long as the form of each remains unchanged; and for this reason the result would be the same from such measurements whether the curves were coincident in time, and the current curve occupied the same position as the curve E, or were displaced as shown in the diagram. In the former case, as there is no displacement of phase, the products of current and electro-motive force at each

instant would be positive; that is, work would be done at each instant upon the external circuit, except when passing through the values of zero.

The effect of the displacement of the current phase is shown in the lower figure, where a curve is drawn to show the phase of work done at each instant of time when the lag of the current phase is of the amount here represented. At 1 no work is being done, since the product of E and C contains a zero factor. Between 1 and 2 we have work done by the coil, since the electro-motive force is positive at the same time that the current is negative. Then we have a period in which work is expended by the generator; and then at 3 again work is restored by the circuit to the generator. By still further displacing the current phase the amount of work restored to the generator may be greatly increased. The example I have taken, a retardation of about one-sixth of the phase length, is a very moderate one, and easily realized in practice, and yet the amount of energy restored to the circuit in work done by the coil is nearly one-fourth of the apparent amount of energy expended, as shown by the product of current and electro-motive force. The diagrams are not intended to show the exact forms of current phase, or of the phase work done, but they are sufficiently near average conditions for purposes of illustration.

A retardation of one-fifth of the phase restores about one-third the apparent energy to the circuit, and beyond this point the proportion restored increases in a high ratio.

The actual work done can never be more than the

product of current and electro-motive force, and may easily be only a small fraction of that amount.

To show that this retardation is not an imaginary thing, but may have a very decided influence on actual measurements, I will describe two experiments which show phenomena that can be accounted for in no other way, or at least cannot be explained by the ordinary rules of direct current measurement. An experiment by the writer similar to the second of these was described by Mr. Stanley in a paper before the New York Society of Engineers some weeks ago, and is still another example of the same phenomenon.

In figure 3 two conductors, A and B, are shown,

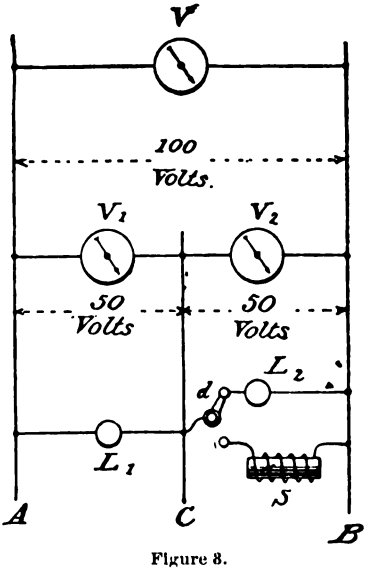


Figure 8.

between which an alternating difference of potential of 100 volts is maintained, and indicated on the Cardew volt meter V.

Between these two conductors a third, C, is placed, and two Cardew volt meters, V^1 and V^2, are connected across the two circuits, and show by the sum of their readings the difference of potential between A and B. They should, under ordinary conditions, agree with the reading of the one at V. Between A and C is connected an incandescent lamp, L^1, and between C and B, through a switch, d, the circuit may be closed either through the lamp L^2, or through a coil of wire S, which surrounds a soft iron core. With the connections as shown in the diagram, that is with the switch connected to the lamp L^2, a perfect balance is obtained, and by adjusting the difference of potential between A and B to 100 volts, we obtain readings of 50 volts on each of the volt meters V^1 and V^2. If, however, the switch d be transferred to the point which connects it with the coil S, a somewhat remarkable effect is observed. The readings of the volt meters at V and V^1 remain constant, since the coil has been so proportioned by trial as to exactly replace the lamp L^2 and maintain L^1 at exactly the same degree of luminosity; but the volt-meter, V^2, instead of remaining constant in its indication, as might have been supposed, increases its indication to 80 volts, so that we have our choice, so to speak, of two measures of the difference of potential between the conductors A and B. These are of such large cross-section as to be of sensibly the same difference of potential throughout their length. Measuring at V we have 100 volts as before, but at V^1 and V^2 we have the sum of fifty and eighty, or 130 volts. It is quite evident that there is some condition present, entirely remote from any which could be produced by the action of direct cur-

rent; for it is absurd to suppose that at the same instant of time we can have two separate values for the difference of potential between the same two points. The natural inference seems that these measurements show in reality only the average of effects which occur successively, although they appear to be simultaneous.

When an impulse from the generator occurs, current flows through V^1, and V^2 instantaneously, and this would give a reading of 50 volts on each if acting alone; but the same impulse, acting through the coil S produces a current which, owing to the self-induction of the coil, lags behind the electro-motive force, and therefore the coil must restore work to the circuit at some point in the phase. This work is partly expended in the volt-meter connected to the coil, and for this reason it gives a higher reading than the other.

Figure 4 shows a second arrangement in which the current is indicated by a Siemens dynamometer D,

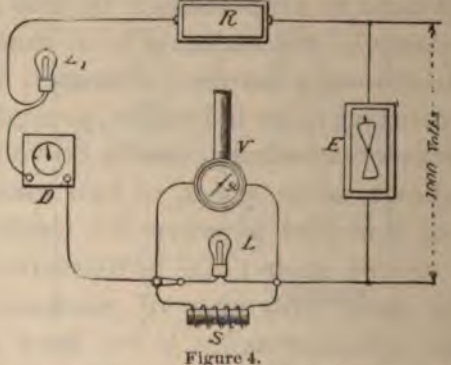


Figure 4.

and the difference of potential is maintained constant by the electro-meter E. The current may be adjusted to the proper amount by means of the resistance R, introduced in the circuit. An incandescent lamp L^1, is also

placed in the circuit in series with the dynamometer, to indicate to the eye any fluctuations in the current. At L a similar lamp is placed, and around its terminals is shunted a properly proportioned coil S, surrounding an iron core. A Cardew volt-meter V, is connected at the same points to show the difference of potential. With the switch closed the normal current passes through the lamp L, and a difference of potential of 50 volts is shown on the volt-meter V. The dynamometer shows one and six-tenth amperes to be passing through the circuit, and the electrometer indicates 1,000 volts. On opening the switch, a slight increase of current is shown by the dynamometer D, while the difference of potential at E is constant. The only change in the arrangement of the circuit is that the current instead of passing through the lamp L, and the coil in parallel, now passes through the coil alone, and yet instead of 50 volts the volt-meter now indicates 148 volts; so that we apparently have 98 volts more in the circuit without noticeably changing the difference of potential at the terminals, and without sensibly changing the current; or, to look at it in another way, we have, under a constant potential at the extremities of the circuit, introduced an apparent resistance, and at the same time increased the current traversing the circuit. We have here a case similar to the former one, and as the explanation is much the same, it need not be repeated.

The question naturally arises, what influence does this new element of self-induction have upon the possibilities of practical measurements of the alternating current in commercial work? As was stated in the beginning, the practical effect is almost negligible, for

there are two cases in which the time element enters to such a limited extent, if at all, that the measurements may be made with perfect success in precisely the same way as if direct currents were employed. These are, first, the measurement of current through an incandescent lamp supplied by an alternating current directly from the generator; and second, the current supplied to lamps through the medium of converters with cores far below saturation and carrying a fair proportion of their full normal load. There is a third case, however, which arises in practical work, in which the central station instruments give a somewhat false notion of the actual energy being transferred to the circuits, and this is the one in which a large number of converters are connected to the primary circuit but with the secondaries open. In this case the effect of self-induction is at its maximum, and there is, consequently, a lag in the current, which, in a well-constructed converter, approaches the theoretical limit of a quarter phase; at which point no energy would be consumed, while at the same time a considerable reading might be shown on the current instruments. This apparent difficulty is not a real one, since even the full amount of current shown by the ammeter only constitutes a small percentage of the total output of the plant, and may practically be neglected. Even a small number of lamps in service distributed among the converters greatly reduces this error, and for this reason, even while running with a light load, the ammeter at the central station very nearly corresponds to the number of lights in the service; while at full load the reading is as accurate as if the current passed directly from the generator to the lamps.

It ought to be evident, however, from what has been shown, that the method which has sometimes been adopted of turning off all the lamps from the secondary circuit, leaving the primary connected to the generator, to show the amount of energy lost in conversion, is apt to give very misleading results unless the proper correction for retardation is applied.

The best proof of economy in the use of converters is that a test of the power expended in running a dynamo at its normal electro-motive force, with its circuit closed through the primary coils of its full complement of converters is the same as when the primary circuit is entirely open, within the ordinary limits of error of measurement.

O. B. SHALLENBERGER.

THE UNDERGROUNDING OF ELECTRIC ARC LIGHT WIRES.

This topic is one of absorbing interest at the present time. Municipal and legislative authority seeks to compel the burying of all wires without discrimination, and to cast upon the parties interested the burden of finding a practical means to accomplish the end. The progress of invention in science and art records, infallibly, the cotemporaneous public demand. This demand discloses a necessity, and inventive ingenuity suggests the remedy. Starting from this standpoint, we find public wiring began with the telegraph.

In 1753 Mashall of Paisley evolved an electric tele-

graph wherein insulated wires were to be trained on poles, and so Lomond in 1787; Betencourt in the same year; Riezen in 1794; Cavallo in 1795; Salva in 1796; Sommering in 1809; Coxe in 1810, and Sharp in 1813 all had telegraphs, employing from one to twenty-six wires, trained on poles. At this stage, however, the interesting experiment to which the world lent a helping hand, developed signs of commercial utility and value. Man's cupidity and selfishness at once antagonize what he cannot share, and we find the public arrayed in opposition to the use of the highways. Inventive ingenuity came to the rescue, and in 1816 Ronalds erected and used a telegraph in which some of his wires were placed on poles and some were buried in the ground. Tribaoillet followed in 1828 with a system employing underground wires; and when Prof. Morse, in 1832, brought out his system, he proposed connecting Washington with Baltimore, a distance of 44 miles. To his mind, the wire should be insulated, and laid in a lead tube in the ground. He constructed his line with great care, and at large expense; but only a few miles had been laid when the gradual escape from his line proved his scheme impracticable. He was about to abandon the undertaking when one of his co-adjutors, Dr. Page of the Patent Office, or Prof. Henry of the Smithsonian Institute, said to him—"Take your wire from the ground and train it on poles." The advice was followed, and success achieved. Here, then, in the incipiency of public wiring, is the first recorded failure coupled with its remedy—"Take the wires from the ground and put them on poles."

With underground telegraph and telephone wires the

electrical difficulties to overcome are much the same. Moisture must be excluded from the wires, insulation must be good, and induction be reduced to the minimum, especially between adjacent lines. In both, however, leakage from the lines due to imperfect insulation may be compensated within limits by additional battery force. The battery acts like a pump sending water through a leaky pipe, the water may all escape before reaching the discharge end; but with a more powerful pump, while increase of pressure will cause greater escape through leakage, one may succeed in discharging a limited quantity through the end of the pipe, and so accomplish the object sought.

For this reason underground telegraph and telephone wires may be operated with a measure of success.

In most of our cities all telegraph wires might be led to a certain point from which the wires of all systems could by one underground conduit be led to a central station or stations, and thence back through the same conduit, and where the wires are numerous might warrant the expense.

With telephone companies whose subscribers are in all parts of the city, the requirement that each wire should be conveyed underground would involve an outlay for conduits wholly prohibitive.

For direct service incandescent lighting the required conductors are so large that to train them upon poles or to train an equivalent capacity—in smaller wires on poles—would involve outlay and annoyance exceeding that required to underground the conductors.

So again the resistance of the conductors to the flow of the current is exceedingly slight; it might be com-

pared to the pouring of water from a pitcher through a six-inch pipe—its course of least resistance lies right forward through the pipe, and there is little tendency for it to seek an exit through any other restricted channel.

In comparison with it the arc light current might be likened to a large hose with a small nozzle, through which water is being forced with a powerful pump; the tension is very great, and if so much as a pin-hole exists in the hose, the water will squirt therefrom, and quickly enlarge the orifice to a fatal rent.

From the fact, therefore, that telegraph and telephone, and incandescent electric light wires may be trained underground with success, by no means does it follow that the same is true of arc light wires.

It is an undoubted fact that to successfully underground electric arc light wires involves simply and solely a question of expense. But expense may be of the very essence of the inquiry, for if the expense is out of proportion to the revenue that can be derived from the service, expense alone prohibits the outlay and determines it to be impracticable. Expenditure of money is alone required to tunnel the Dover Straits, and yet French and English capitalists have pronounced it wholly impracticable, as the returns could not warrant the investment. So it is with electric arc light wires; an efficient system, so far as inventive ingenuity has yet presented any plan, involves an expenditure wholly prohibitive, and for that reason alone is impracticable.

Electric arc light wires may be employed successfully trained in the air on poles, and an underground

system is practicable which can reproduce the same conditions. All substances are conductors as copper, iron, lead, rubber, glass, dry air. Some subtances are such poor conductors, that, in comparison with those that are better, we call them non-conductors, and the greatest available non-conductor is dry air. We use these poor or non-conductors such as rubber, glass, parafine, wood and dry air as insulators, and we find dry air to be our most perfect insulator. Dry air is a better insulator than rubber; if, therefore, in dry air two rubber covered wires cross in close proximity to each other, the induction is greater between them than would be the case if both wires were bare. But air is usually laden with moisture, and water, charged as it is with the mineral salts and acids of the atmosphere, is a good conductor. We, therefore, coat our line wires with an insu lating material, to shield them from direct contact with moist surfaces or other good conductors, and so reduce in amount the current which is always escaping by connection to the ground and which varies in direct proportion to the conducting property of the intermediate medium.

Where insulated wires are trained on poles, we have at the rate of 30 poles to the mile, thirty points at which a small amount of current may and always does escape to the ground.

Now let us put an insulated cable in the conduit in the ground. The conditions are all changed in the most aggravating manner.

Instead of comparatively dry air, the air is clammy and heavily laden with moisture, instead of a mass of surrounding air as on the poles, the envelope ot air is,

at best, but an inch more or less in thickness. Instead of resting at 30 points in a mile on glass support, connected to dry non-conducting wooden poles to make the passage to the ground as much obstructed as possible, the line touches the conduit at say two or three points in the space of every foot or at say ten thousand points in a mile, and the conduit itself, a much better conductor than glass or dry wood, is all that separates it from the earth.

The bearings at which the current may seep away have been multiplied from thirty contacts to ten thousand contacts per mile while the conductivity of the medium at each point has been greatly enhanced.

A regular arched subway has been suggested, and approaches most nearly to a successful plan, but only a state or city could stand the necessary outlay. A subway of this character, four feet wide and eight feet high for Chestnut Street alone, in Philadelphia, was estimated would cost the city $1,500,000. After completion such a subway would have to be supplied with forced ventilation to keep it dry. If then the insulated wires could be supported so as to touch at but thirty points to the mile, the conditions of exterior wire training on poles would be fairly approximated.

The question is frequently asked: If telephone and telegraph wires can be undergrounded, why cannot arc wires? The reason is plain, seepage or escape can be supplied in the former by additional battery power but an arc light generator is a queer specimen of mechanics.

It starts a mild current, and this passing back around its field magnets builds them up; the increased magnetism induces greater impulses in the bobbins of the

armature; the current thus increased continues to pass through the line and back around the field magnets until the current has reached its maximum. It is therefore apparent that anything which seeps the current from the line, not only steals the quantity which has escaped but prevents just so much current from passing back around the field magnets and to that extent robs the machine of its capacity to generate a current. These machines are capable of taking care of the small amount of loss at the insulators in the pole and line system, but when this is multiplied many times as in an underground conduit it is so robbed of its power to recuperate that the resulting lights are necessarily reduced in number and are weak and sickly.

Operations looking to the undergrounding of arc light wires have been prosecuted on a large scale at New York, Brooklyn, Chicago, Philadelphia and Washington.

Notwithstanding all reports to the contrary, I find that at New York, although the Subway Commission has expended vast sums of money and has succeeded in burying certain telephone and telegraph wires, no arc light line has up to this time been buried in New York City, and this is fully corroborated by the report of the Board of Electrical Control of January 6th, 1888.

At Brooklyn, New York, the Board of Commissioners of Electrical Subways, instituted thorough investigation of this subject in 1886, and in its report of Dec. 30th, 1886, says: "With regard to electric light conductors, this Board has found no device which would, with certainty in its opinion, enable the wires carrying arc light currents to be safely and successfully operated

in the same conduit with telephone and telegraph conductors without disturbance or injury to the latter. . . But the Board desires to say, emphatically, that those fluent critics who talk of putting electric light conductors underground, making no distinctions between arc lights and incandescent lights, or between the arc lights of different systems, are ignorant of the alphabet of the subject." The President of the Board visited all the principal cities in Great Britain and Europe; he found no arc light wires underground, and although a few years since such wires were trained in the Paris sewers, they have been removed, and no arc light wires are now allowed therein.

The Brooklyn Commission made another report, Dec. 15th, 1887, and on this topic says: "As was fully explained in the last report, the subject of underground conduits for arc currents is the one which presents the most numerous and novel difficulties. Since it has been impossible for Brooklyn to take the lead in the experimental solution of these, the only remaining course was to watch carefully the progress of experiments in other cities. This has been done, both by correspondence and by personal visits of members of the Board. The principal cities in which experiments of this kind have been in progress are New York, Chicago, Philadelphia, Baltimore, and Washington. In one or another of these, several systems, which were regarded with favor a year ago, have developed defects or even come to entire failure. It cannot be said that any system has yet been completely proven to be permanently satisfactory. There are one or two, however, which promise well, and this Board awaits with atten-

tive interest their further trial, regretting only its inability, through the cause already specified, to cooperate in the experimental investigation of the different and delicate questions involved."

There are no arc light wires underground up to this time in Brooklyn. At Washington, in 1884, cables were laid in F Street, from 9th to 15th Streets. In a few months, it was necessary to dig up a few of the same. Later, there was much more trouble, and it was all taken up and re-laid.

About one year after first laying, it was wholly abandoned because they could not make it work. In 1885 they laid cables on Pennsylvania avenue, from Ninth to First streets, and imported an expert from Antwerp to lay them. Twelve cables were laid in solid cement and no expense spared to insure success. They proved an utter failure. The avenue was dug up many times. The wires were, in September, 1887, mostly out of service, and the remainder were in such bad shape that they would require constant repairing or have to be abandoned.

An officer of the Washington Company writes me under date of September 12, 1887: "We have many committees coming here to see what we have accomplished, as they have heard that we have met with great success, and so forth. We will say to you that our experience, after the outlay of many thousand dollars, is this: Have nothing to do with underground cables for arc lighting if you can possibly avoid it. Many will tell you that it is perfectly practicable; look out for such parties; they are probably interested, directly or indirectly, in cables. There is a big lobby

in that branch of business. There is no city or town in the world where a cable has been made to work two years that has been subjected to 2,000 volts pressure."

This Washington company is using lead-covered cables with success for incandescent work; but as to the undergrounding of arc light wires, confirmed as late as February 7, 1888, they report that out of fourteen miles of arc light cable, in fourteen different circuits, all have proved total failures, and have been abandoned, except a very small amount.

At Philadelphia elaborate experiments have been prosecuted. All kinds of cables have been employed and a great variety of conduits; great trouble has been experienced. The systems largely employed were such, having ducts through which the cables were drawn, in most cases the insulating compound rapidly deteriorated and became useless; in others it would be rotted and become water-soaked. Where lead-covered cables were used in conduits where creosote was employed, the effect was to rapidly oxidize the lead covering and disintegrate the same. It was found that gas could not be kept from the ducts, although apparently gas-tight, and many explosions followed. Recourse was then had to ventilation by lamp posts, but the trouble was not corrected. After several explosions in one system, in which persons and property were injured, a power-fan was adjusted to force air through the conduit, deeming it better to do so than to draw the air through, which might simultaneously draw in gas. When, shortly afterwards, the lighting company was congratulating itself that it had overcome the difficulty, a tremendous explosion ensued, extending for a long distance, ripped

up the street and broke a large plate glass window. That entire system of lights had to be abandoned. It was some six months ago determined by the manager that as a result of experience no conduit would suffice for arc light wires in which there were open ducts, and that success lay in the employment of lead-covered cables buried solid. This plan, suggested by the city electrician, was tried, and success seemed assured, but they now report the experiment unsuccessful. The section covered is not great, but three bad grounds have recently developed; two were repaired, but the third necessitated the temporary cutting out of a part of the line and the training of wires on poles, until the earth may thaw and enable access to be had to the wires.

The various companies of Philadelphia are at a loss what to try next. At this point I would note that these demands for a system for arc light wires have greatly stimulated inventive ingenuity, but as yet without success.

Out of the 72 patents that have been issued in this line, 53 of them have emanated from Philadelphia, New York, Boston, Brooklyn, Wilmington, Camden, and Washington, all being in the immediate vininity of the places where the operations were being conducted. The others were mostly from the general vicinity of Chicago.

Now as to Chicago, much has been said of its system, a visit to Chicago satisfied me that its electric arc light industry was being strangled.

A few blocks in the immediate heart of the city were using electric light very lavishly, but the area lighted is scarcely a half mile square. This small area is served

from no less than nine seperate plants, formerly belonging to as many companies, but now consolidated into one.

A letter under date of September 20, 1887, from an officer of the Consolidated Company, explains the situation there. He says: "We have had an enormous amount of trouble with our underground arc light circuits, averaging, I would say, for the last three months, one burn-out every day. The expense of reconstruction and the losses in rebates have been enormous and the annoyance to our customers more damaging still. Commencing in April last we bought out some nine arc light plants in Chicago, and have proceeded to concentrate them into four main stations burning about 1,100 lights, their owners had all been using underground conductors composed for the most part of Okonite, Kerite, Callender and Underwriters' wires. Every one of these insulators has failed constantly, the only thing that has held up at all is lead covered cable, and we have been driven to the great expense of taking out every foot of the old constructions and substitute new lead covered cables throughout. This work is not yet done. Our people are confident that a large business awaits us here, but its development will depend entirely upon service. These lead circuits may fail much sooner than is anticipated, and it is almost certain that we shall be compelled to reduce the number of lights upon a circuit, a very difficult matter in a city like Chicago. Our conduit space is already filled along the main routes and additional conduits will be necessary. The constant tearing up of the pavements for all kinds of purposes makes our

Street Department very unwilling to grant permits for laying additional conduits and several times they have been refused altogether. I would say here that arc light business in Chicago has developed entirely since the passage of the underground ordinance of 1881—the result has been the multiplication of small isolated plants and the formation of the nine small central station plants bought out by this company. None of these plants made any money. It was impossible for them to do so, operating underground and upon so small a scale. No streets have ever been lighted by electricity here, in fact the whole industry is in a very backward condition and is likely to remain so except in the most densely crowded portion of the city, unless some arrangement can be made with the city authorities for overhead wires. The city is trying an experiment of its own in lighting Chicago river, which will, I am confident, demonstrate the truth of the foregoing statement; and in the course of a year I hope that our city fathers will permit overhead lines, in many places where public convenience demands electric lights while underground construction would forbid it.

At Milwaukee, Wisconsin, three systems have been tried and abandoned—*i.e.*, a wooden trench, plain and tarred—iron pipe—and grooved wood. A fourth, consisting of tile conduits, with a heavily-insulated but not lead-covered cable, has recently been iutroduced, and is now being tested. The company doubts whether it will stand the trying spring season.

At Detroit, the Thomson-Houston Co. employed a cable of the most expensive and approved character in the Dorsett conduit, and the mechanical work was of

the best quality. While the cable was new the results were fair, though loss by seepage rendered it impossible to produce normal lights. It was found impossible to operate telephone wires in the same or adjacent pipes. The company soon abandoned the system, and when its cable was removed it was found the insulation had so rotted or softened that considerable lengths of the wire in many places was stripped bare.

With the alternating system, some wires have been undergrounded in Springfield, Mass., and in Denver, Colorado, and a small amount in Pittsburg; but the voltage is only half that of the arc light systems, and even with this low voltage the lead-covered cables have not been in use long enough to determine the question of their success.

The difficulty from explosions of gas has been met with many times in Chicago, New York, and elsewhere, as well as at Philadelphia, and seems insurmountable where gas is employed. At New York men have been suffocated in the manholes; and in the Western Union building the escape of gas from their conduits has been almost unbearable. At Detroit, an explosion took place in October last, in the middle of the night, in a fire-alarm conduit with close manholes, and in which no wire had ever yet been placed. It doubtless occurred through the admixture of illuminating gas and sewer gas, or other exhalations, in proportions to explode spontaneously. The manhole cover was thrown high into the air, the street torn up, and the paving blocks scattered over a distance of eighty feet or more.

The problem of undergrounding arc light wires is by no means solved, but appears to-day to be further than

ever from solution owing to the utter failure of system which apparently had all the elements to insure success. In this emergency municipal bodies must suit their action to the facts. To legislate arc light wires beneath the ground when no practical system is presented for accomplishing that end, is actually and literally to bury the system.

When a city is so sanguine of the soundness of its judgment the remedy would seem to be for the city to provide conduits and the necessary cables, guarantee their success, and then compel lighting companies to rent their lines at a proper figure or failing so to do to quit the field.

Summary action on any other basis is incompatible with that justice and equity, which it is the inherent right of every person to demand and receive. Any other course is to discourage enterprise and to ruthlessly impair or destroy capital invested in good faith.

The difficulty usually met with is a peculiar and unreasonable one. Municipal and Legislative bodies view with suspicion the lighting companies, their officers, stockholders and every body connected with them. It seems to be assumed that because the companies make a certain showing of facts, the facts must necessarilly be exactly the contrary and they legislate accordingly. Thus at Detroit in opposition to letters produced by the lighting company alleging repeated trials and failures at Washington, Philadelphia and Chicago, the then Mayor, unquestionably in good faith, reported to the council, as the result of his personal investigation upon the spot, that no electric light wires had ever been buried in the city of Washington, — a most glaring

error— yet this was followed by a report of the committee and unanimously adopted by the council that underground system of electric arc light wires were entirely practicable and were in successful use at Washington, New York, Philadelphia and Chicago. At Cleveland, recently, the strongest argument in the underground struggle advanced by the city was that the wires of the Thomson-Houston Co., of Detroit were operating underground in the Dorsett system whereas not a foot of arc light wire is underground in Detroit.

To combat this unreasonable and unreasoning prejudice the question whether any system yet discovered is practical and sufficient for the purpose, should be thoroughly and exhaustively examined and an elaborate report made and published with full data upon which the conclusions are reached; this should be done by a Board of competent and eminent men of National repute entirely disconnected from the electrical business, such as could be gathered from the scientific chairs of our largest colleges and polytechnic Institutes, and it would rest with the interested companies of this Association to contribute from their own funds or to influence the necessary contribution by the councils of their respective cities to pay the necessary expenses of such an inquiry.

WELLS W. LEGGETT.

UNDERGROUND CONDUCTORS FOR ELECTRIC CURRENTS.

The question of underground conductors of electric current is one which every person interested in electricity should study fairly and with a predetermination of solving. It is not purely an electrical question, in fact the electrical part of it is far overbalanced by the mechanical. There is no difficulty in finding an excellent insulating material, but the difficulty lies in the holding of this insulator on the conductor. Many substances are good insulators in dry places; some are good under water; some in damp places; and a few will stand acid and alkaline fumes and the ravages of sewer and illuminating gas, but how many will insulate under all these conditions combined, and in addition be substantial enough to withstand the mechanical injuries to which they are exposed when buried under the streets of our large cities?

A few years ago wire wound around with a little cotton soaked in paraffine was thought sufficiently insulated until the insurance companies had a few losses, due of course to electricity, and then we had Underwriter's wire. The name of this wire has sold hundreds of tons of it, but that does not prevent its grounding a whole system when it comes in contact with the least moisture. It, however, marks one state in the evolution of the perfect insulation.

There seems to be comparatively little difficulty in making a cable that will carry high potential currents when constantly submerged. The conditions are substantially the same at all times. There are no alternate changes of moisture and dryness; no great changes of

temperature; and very little of the destructive action of gases.

The conditions of the underground conductor are very different.

Here the conductor is dry, then wet; it is frozen, and again thawed; it is attacked by sewer gas, and the corroding action of water leaking through the accumulated filth of the street; it is subject to the destructive action of the leaking gas and steam pipes and finally, but not the less surely, to the ruthless "ditch digger".

These are certainly formidable obstacles but a number of them have already been overcome and the others must be. Public opinion says the wires of all kinds must go underground, and electricians, engineers, and capitalists must find the means of doing it.

The question resolves itself into three parts—1st, The electrical insulation of the conductor; 2d, the protection of the insulation from the effects of moisture and corrosion; 3d, the protection of both from mechanical injury.

The question of electrical insulation seems to me to be solved by at least six of the standard compounds now in daily use. The second part of the question is the most serious. If any of the standard insulations can be enclosed so as to be protected from direct contact with moisture their chances of life are certainly improved, but if they can be hermetically sealed, they should be practically indestructible, provided the casing is indestructible. We single out as among the best materials from which to form such a casing—iron and lead.

Cast iron, underground, will last a great number of years, as shown by gas and water pipes, but it cannot

be obtained in lengths much over 12 feet, and the numerous joints multiply the chances of leakage. The conductors must of necessity be drawn into the pipe after it is in place. The conductor must be considerably smaller than the pipe, and therefore moisture will creep in between the two. Wrought iron pipe, if well coated with asphalt or some similar substance, will also last a long time. It may be had in longer lengths than cast pipe, and the joints are more easily and surely made. If screw-threaded joints are used, the conductors must be drawn in, with the same objections as with cast pipe. If the lengths of pipe are prepared with the conductors in them before laying, joints must be made in the conductor, as well as in the casing, at short intervals.

Joints are the bane of electrical construction. From the dynamo to the lamp and return, the current is forced to pass joints which frequently offer more resistance than 1000 feet of wire. At these joints the insulation, instead of being better than at other points of the conductor, is generally worse, and oftentimes none at all is found. It is not strange that the current should seek an easier path home, and take to ground, rather than be forced through the accumulated resistance of all these joints. I will venture to say that, of all the failures of underground conductors, 90 per cent. are directly traceable to the joints, and for that reason it is desirable to have as few as possible.

The conductor may be obtained in, practically, any length, and the insulation may be put on continuously, but in order to have a continuous casing it must be formed of some soft and ductile metal which can be

closed about the insulated conductor in the course of its manufacture. Lead seems to be the only commercial metal that will fill these conditions, and there are objections even to it. Lead is soft and easily punctured, and offers but little resistance to crushing or bending, and is attacked by rats. On the other hand, the corrosive action of the earth has little effect upon it; while its pliable nature permits of its use in many places where iron pipe could not be used. Being soft and ductile it can be brought into such close contact with the insulation as to prevent, or at least retard, the creeping of moisture between the insulation and casing. It seems to me therefore that lead casing offers more advantages and less objections than any other form of protection to insulation as yet open to our use.

The third part of the question, viz., the mechanical protection of the casing, and hence the conductor, is not so difficult a matter. If an iron casing is used, little or no protection is needed. The pipe is strong enough in itself to withstand any ordinary abuse. If lead is used, however, it should be kept from contact with sharp stones, bits of glass or metal, and have something about it to warn the ditch digger before he strikes it with a pick. An ordinary square wooden box is oftentimes sufficient. If it does rot away it leaves a bed of soft mold. The box may be made of white oak well creosoted, in which case it will last until the next generation finds something better. If the underground conductor is to come into practical, every-day use, it must be so constructed that it may be tapped at any point, as readily and with as much certainty as a water main is now tapped. How many miles of lead water

pipes are now buried in our streets? They are not protected by boxes or conduits of any kind, yet it is comparatively rare that we hear of their failure. If such pipes filled with water can be laid in the earth without protection, why cannot a lead pipe filled solid full with copper and insulation be buried with even more success? Good workmen can certainly be found who can cut a conductor, splice in a branch and solder it, replace the insulation, and finally wipe a joint on the lead casing with as much ease and certainty as a plumber can make a joint in a lead water pipe and have it stand 100 pounds pressure.

In a general system of distribution there are two classes of conductors, one which we may call through mains or feeders, and another service mains. A number of through mains may be bunched together in a cable, under one casing, where they run in the same direction for considerable distances. These may be drawn into conduits, as they are not to be used between the main distributing points.

Service mains must, however, be so constructed that they may be tapped at any point, and that very readily. Large sums of money have been spent in New York and elsewhere on conduits for electric conductors. Are conduits necessary or desirable in electric lighting? Service wires are of no use whatever if placed within them unless man-holes are provided at every 100 feet. Through mains are certainly well protected when drawn into conduits, but at a great expense. No engineer would, I think, at this day, risk putting a conductor in any conduit which he would not be willing to trust under water or laid directly in the earth. Why

not take one-half of the money which these conduits cost and use it in buying thicker lead casing, and bury the conductor directly in the ground or in a common wooden box? The underground conductor of the future, I believe, will be formed with a core of copper cable, thoroughly insulated by any of the standard and well-tried compounds, protected by a close-fitting lead casing, thick enough to resist mechanical injury, and buried in the earth in such a manner that it may be tapped at any point.

But where is the money coming from to pay for these conductors?

Whenever electric light plants are installed in a thoroughly mechanical and substantial manner, with due regard to the most economical production of power, so that the electric light is perfectly reliable and obtains the public confidence, then the money will be forthcoming. When capital enough is invested in electric lighting to enable it to cope with the vast sums which have been accumulating these many years in the gas industry, then we shall see our dynamos driven by the waste heat and refuse products of the gas works, and our houses will be heated by gas and lighted by electricity.

JESSE M. SMITH.

THE PRESIDENT: The four papers are now before the Association for discussion. I would suggest that the first pair be taken up first; —the practical side of the alternating current, the energy of the alternating current; and let us have a general discussion on these

most important topics; and then we will discuss the underground question.

Dr. Moses: I have the pleasure of announcing to the convention that we have in our midst this morning one of the most distinguished electricians of England, Prof. George Forbes, to whom the courtesies of our Associations have already been extended. As he is full of ideas, even to overflowing, he will perhaps allow us to puncture him somewhere so as to enlighten us. I hope that he will give us his views in the discussion of these various papers; or in making any suggestions which he may think apposite to the subject. I know that it will give us all very great pleasure to listen to him.

The President: The Convention will be pleased to hear from Prof. Forbes.

Prof. Forbes: While I appreciate the honor you give me, I feel that on the particular points which have been raised at the present session there is not a great deal that I can say which would enlighten the people here in America as to what has been done in Europe. At every step as I go through your different cities I see how enormously ahead you are of us in England. A great deal of the subject of the papers which have been read has referred to the question of insulation, and as to the laying of overhead and underground conductors. Our experience in England of course as to underground conductors is almost absolutely nothing, for the simple reason that our people will not allow us to put our conductors under ground. The public in England have a strong feeling that there ought not to be any overhead conductors; they would not allow wires on poles as you have them here—which is a very cheap and con-

venient method; and our telephone wires have hitherto been carried from roof-top to roof-top—standards being erected on the roofs; and there is a general feeling among the public that electric light wires ought not to be overhead, and ought to be underground. Electric light companies also feel that they would prefer to put their wires underground. The opinion seems to be different over there to what it is here. The idea in England is not so much to make a cheap outlay at the start, as it is to make an efficient system—a system which it will be able to work afterwards. It is the general opinion of a great number of companies that the best arrangement could be got by underground work. However, Mr. Chamberlain, in 1883, thought it wise to practically prohibit electric light companies from putting their wires underground. The consequence was that for several years after that it was absolutely impossible to start a central lighting station. At the present moment the demand for light from central stations in England has become so great that the companies who are capable of doing the work are determined that they will satisfy the public demand; and the consequence is that now at the present moment central stations are being started in London and in other towns, but always on overhead systems. That is what the Government has driven the electric light people in England to. I may mention that the insulation which is used in electric lighting overhead work in England for the alternating current, where 2000 volts are used, is very superior to what you are using over here. The best possible insulation, of India rubber and tape of several servings, is being used in the central station

lighting, which is done on a large scale there—viz., from the Grosvenor Gallery in London. I have always thought that that was very wise; but I must say that from inquiries here among those who have been using alternating currents of high potential, I find that a less expensive wire is certainly doing admirably; and I think it is just possible that we have perhaps overdone the matter in England in the way I speak of.

I cannot speak upon the subject of Mr. Carpenter Smith's paper on the alternating system here. It is a most valuable paper, and one from which I myself have learned a great deal, and have taken numerous notes for our benefit on the other side of the water. With regard to Mr. Shallenberger's very interesting paper, I may say that I think those experiments which he has described are very beautiful indeed. I have been lately much occupied with the theory of alternating currents. The point which he has chiefly brought before us is this,—that you must not try to get out of an alternating current circuit the work which is being done in that circuit, simply by multiplying the volts by the current; because there is a difference between the current and the expressed electro-motive force. As matter of fact the formula comes out very simply indeed, — that the true work is really the product of the electro-motive force multiplied by the line current. I have communicated this formula to the Society of Telegraph Engineers of London since my departure from London; and it will probably come to those who are interested in applying the formula to practical work.

I do not think that there is any point on which I can give information here; but I shall listen with great

interest to the discussion. Since the subject of alternating currents has been brought up I wish that somebody had given us a little information about a question which has been occupying my attention much during the last year, in connection with alternating currents — the question of meters. I would like to hear what has been done in the matter of meters for alternating currents; because it strikes me there lies one of the chief difficulties in the practical working of central station lighting. Having my own idea of the solution of the difficulty, I would like to have heard here from other people what the complete solutions are, or else what are wanting. I think that would have added to the interest of the discussions on the alternating currents. I am sorry that I really have nothing to give you that would be of value to the Association.

Dr. Moses: I am delighted that the article which Prof. Forbes has elaborated will appear very soon. I had occasion to try one of his formulae, and it was practical and useful. With regard to the question which he asks, about the measurement of alternating currents by means of a meter, it is of course a most important question, and one lying at the very root of all electrical distribution. In fact, it was one of the first ideas evolved as to the distribution of electric currents over large areas for ordinary use as a substitute for gas for illuminating purposes. The question of meters was not then considered particularly; and it was resolved to adopt a continuous current, not because a continuous current machine as then known was better than an alternating machine, but simply because continuous currents permitted of the registration of the amount

of electricity consumed in any work by the various methods known at that time. When that was finally adopted by Mr. Edison, who first worked in that direction, he took the electrolytic method. That had already been discovered and elaborated in a most magnificent manner by Faraday, who had theretofore discovered so many very important facts, and among them I might name the sublime law of chemical equivalents. That had been completed before, but he adopted it in his system for the measurement of continuous currents. It was simply a question of deciding on which side of the mountain range the water was going to flow. I speak of him as typical of those who have adopted continuous currents for distribution. Before this, of course, the alternating current had been used for lighting purposes; and, in fact, the first dynamo machine that was made was an alternating current one, but there were some practical difficulties in the way. And here, parenthetically, I wish to say that so great an authority as Bacon has said that one should be aware of "things"—meaning by that popular reports flying about. He cited one case, which will illustrate by anecdote what I mean by "things," when he said that Cæsar managed to come into Italy by spreading the report abroad that his soldiers were afraid of Pompey's; the actual fact being the reverse; and Pompey's men then became over-confident; and we know the result. The fame was spread abroad among the people at one time to the effect that the Pixey machine, and other machines which introduced the alternating currents, were highly dangerous. They were used for medical purposes; and whoever has had

an induction coil put through him does not want it a second time, if he is at all sensitive. For that reason alternating currents were abandoned, and for no other reason that I know of.

Now, we come along to another period, when people had become familiarized with the handling of currents, and it has been desired to use the alternating currents for illuminating purposes. It has been successfully introduced, but that link was wanting which the far-seeing mind of Mr. Edison supplied in his particular system of distribution,—the meter for the registration of the quantity of current consumed. Everyone is familiar with the gas meter; everyone knows that while it is altogether unreliable, still it is a kind of fetish that we must worship; it may tell the truth; it generally does not; but still, it is a something. Now, in the alternating current distribution there has heretofore been no such thing. I am glad to say that I have had the privilege—one of the many privileges extended to us all here by the Westinghouse companies—that of inspecting every part of their vast establishment,—they throwing open to us all their secret doors, and in fact focusing our attention on the things that we would like to see. And, among other things, I have seen a meter which I would take occasion to particularize here as being one most admirably adapted to the registry of alternating currents,—and with this excellent addition —that it will speak the truth; and with this corrolary to it—that we can verify it ourselves; and we do not need inspectors to go around; we do not need to use weights and measures made by ourselves. I have to speak guardedly of this, because I was told at the time

that the meter was shown to me, that while it was shown, still for certain reasons connected with the taking of European paients, and such things, it was not desirable that the particulars concerning it should be promulgated; but I vouch for its success and accuracy. That meter is absolutely positive,—it is simple, accurate, and cheap. It cannot get out of order. We cannot doctor it. It is there to speak as truthfully as the current itself. I am also very happy to say that a meter which is a most ingenious and practical, as well as scientific, piece of apparatus, has been invented by Prof. Forbes, which I have not had the pleasure of seeing, but which I have read much about, and which also answers many of the conditions.

Now, gentlemen, I think that if you will take the answers of Prof. Forbes in a more earnest way than you took my first proviso about the success of the alternating system; and if you will only accept that statement, you may go home perfectly satisfied that hereafter alternating currents will be sold by the measure, by the quantity of the current absolutely consumed, and that the supervision of the bills charging for that current can be overlooked by the consumers themselves without any difficulty whatever.

Mr. Lockwood: I would like to ask Prof. Forbes a few questions with regard to underground wires in England. In 1881 and 1882 I had occasion to be in in London, and to investigate somewhat, while there, the underground wires of the arc light company, or of two companies especially, and they were the Brush company, operating the Brush system, and the Electric Light and Power Generator Company of London,

operating the Weston system. I understood while there that within one year's time the Brush company were forced to renew three times the cables which they had laid down in Cheapside, in the lower part of London, and that each time they put in the kind of insulation that Prof. Forbes speaks of as being preferable in England, the India rubber insulation; their cable being laid at that time by the India Rubber and Gutta Percha Telegraph Company. I do not remember as the Weston company had replaced theirs so many times, but I think they were replaced twice. I would like to ask Prof. Forbes if he can give us a few points with regard to these companies, and whether they were ultimately successful in getting a cable which would stand the potential.

PROF. FORBES: I cannot answer that quite fully. I can support what you say has been said about the failure of the Brush Company's cables; but I do not think that the statement is correct that they were the work of the India Rubber and Gutta Percha Telegraph Company. I do not think that that was the case. The cables certainly were continually giving out faults in different parts; and enormous quantities of the cables had to be relaid; and, even when they were working at their best the insulation on the line varied enormously with the weather; so much so that on some days it was really almost impossible to work them. Eventually, as was stated just now, the whole of the cables had to be taken up. The best underground cables that I know of are at the works of the India Rubber and Gutta Percha Company where they have had their cables lying for about six years, and lighting the whole of the arc

lights in their large works. They are laid in a conduit, which, however, is not water tight, and the cables in some parts are dry, and in some parts are wet, and in other parts are alternately wet and dry; and they really undergo serious changes by the action of the water, as could be expected; and yet they have been maintained admirably during the whole of that time. I think that is all all the information that I can give on that subject.

MR. LEONARD: If my motion will be in order I desire to move, in regard to the paper read by Mr. Leggett, that it be published in pamphlet form and distributed to the lighting companies of this country, and to members of the Association, for their use. There was some very valuable information contained in that. All the companies who have had to fight for the privilege of going into a city, and who now have the underground question staring them in the face at an enormous expense, feel decidedly sore on that subject. We have, in Indianapolis, about sixteen months yet to run overhead; and at the end of that time we are supposed to go underground. We have worked hard for information on this subject; and the paper presented by Mr. Leggett gives us that information very directly. I therefore move that the paper be printed in pamphlet form for distribution among the electric companies who are members of this Association.

MR. DUNCAN: It seems to me that the proposition is premature, for the reason that the Executive Committee have now in their hands sufficient funds to print in book form the entire records and proceedings of the Convention up to the present time. Immediately upon the adjournment of this Convention the Executive

Committee will bring that record up to date, and include the proceedings of this Convention. You will therefore have the benefit (as every member of this Association will) of just exactly what you want, and with this difference: If you propose to go outside of this motion, and print the papers for general distribution among companies who are not members of the Association, but who are interested in the underground question, you are doing it at our expense, and it is the business of such companies, if they wish to have the information we can give them, to come into the Association. I therefore request the gentleman not to press his motion unless he brings it forward as a separate proposition to print additional copies, which can be obtained from the Executive Committee, or from the publisher—whoever he may be—who shall bid the lowest for the best work that can be done. I think, with this information, that the gentleman will feel inclined to withdraw his motion.

MR. LEONARD: The suggestion of Mr. Duncan is a very proper one; but at the same time I hardly think it would reach the class that I want to reach—the councilmen of our different cities, all of whom are thorough electricians, simply because they have been sent to Chicago and other places on a junketting tour, and have there seen wires underground, and as a result are prepared to say that you have only to make a hole in the ground, put your wire in, and then it is all right; and that anybody can do that. Now, if this were printed in pamphlet form, copies could be distributed very easily, and they would not have to read through the entire proceedings of this convention in order to

reach the information they want, and which we want them to have and to read. I therefore hope that my motion will prevail.

JESSE M. SMITH: I think that Mr. Duncan's suggestion is a very proper one. These proceedings will be published immediately; they can be had by all the members of the convention; and, if parties who are outside of the Association desire the information, let the parties who are interested purchase from the Association the copies that they wish to distribute, and in that way make the publication a source of income to the Association instead of an expense. In that way everything that the gentleman from Indianapolis desires can be accomplished, and all the papers, including the discussions, will come before the public.

MR. DUNCAN: I want to say to Mr. Leonard that this proposition was before this Association at the meeting in Baltimore. The proposition was made there that we print a part of the proceedings on just this issue. We took the ground that, as an Association, while we were willing to distribute the record to the world, and while we are open, free and above board in these discussions, and in all the papers read before the Association, and were ready to give all the information obtainable up to date, still we were not in a position as an Association, to give to any one particular company information on any particular subject which it needs to enlighten its particular Common Council and Board of Aldermen. We say to those who ask such assistance from us that they can obtain that information, and obtain any number of copies that they may wish, either through this Association, or at the hands of the publisher (whoever

he may be) when the book is published. Therefore it is an outside proposition that we enlighten any particular place where this question comes up. But you will all have these records, the papers and the discussions upon them, and the consideration of the whole subject of undergroud wires from the time it was started to date put before you, to show how slow the progress has been from the start up to the present time. On that information I think that the motion of Mr. Leonard should not prevail.

MR. MASON: I have further information in this connection which may satisfy the gentleman from Indianapolis, and that is, that our electric journals — certainly one of them, and probably more than one—will publish these papers in full; and any number of copies that he desires can be obtained at a very reasonable price.

MR. LEONARD: I did not mean to saddle any additional expense upon the Association, and if there is any expense I will guarantee that our company will be willing to share its proportion, or more than its proportion if necessary. I thought it would be a most excellent paper to be distributed among the people, and to protect those who are striving hard to make a little something out of the electric light business. It would enable them to know that it is possible for them to continue in perhaps a prosperous condition without going to the enormous expense of putting their wires underground. I appreciate the remarks of the gentleman from Boston, and the information that we may be able to get in the electrical papers; but that does not answer my point. I think you can do more work with a small pamphlet of that kind, which you can hand to a person

and ask him to read over, than by asking him to read over the long proceedings of the convention, the arguments on both sides, pro and con, in an electrical paper, which is full of advertisements, and of other reading matter. I hope that my motion will prevail.

MR. MORRISON: I was not present when Mr. Leggett read his paper, and am not familiar with the details of it; but I wish to say this: Be careful how, as an Association, you deal with the question of underground wires; and also be careful how you put yourself on record by taking the ground that such a plan of laying wires is not feasible. I do not intend to take any part in this discussion, either pro or con. Of course I am opposed to underground wires. So is every man who has money invested in electric light. There are a whole lot of things that we are opposed to, but the reasons why we are opposed to them would not look well in print. (Applause.) I move that we now take a recess for an hour and a half, and reassemble at 2:35.

THE CHAIRMAN: There is a motion now before the house.

MR MORRISON: I beg your pardon, I forgot all about that.

MR KINSMAN: Is there any reason why the gentleman from Indianapolis or myself cannot take from that publication which is promised us by the executive committee any part which is especially interesting or valuable to us, and publish it in pamphlet form, at our own expense?

THE CHAIRMAN: There is no objection whatever to that.

MR. LEONARD: Then I will withdraw my motion to print the paper of Mr. Leggett in pamphlet form.

The Association then took a recess until 2:35 P. M.

AFTERNOON SESSION.

The convention was called to order by President Morrison at 2:50 P. M.

The Secretary read a communication from Mr. Benjamin Rhodes, Manager of the Brush Electric Light Company of Niagara Falls, inviting the Association to meet at Niagara Falls next summer.

On motion of Mr. DeCamp the communication was received and filed.

The Committee on Amendments to the Constitution submitted the following report:

The Committee on Amendments of the Constitution respectfully recommends that Article IV of the Constitution be amended to read as follows:

ARTICLE IV.

The President and Vice-Presidents shall be elected by ballot to serve from the close of the annual meeting at which they are elected until the close of the next annual meeting, and the same person shall not be eligible for the office of President or Vice-President for two successive terms.

The Treasurer and Secretary, who may be one and the same person, shall be nominated by the President, subject to the approval of the Executive Committee which shall have power to fix a proper compensation

for his services subject, however, to the approval of the Association. The Executive Committee shall be chosen by ballot at each meeting, either annual, semi-annual, or special, to hold office from the close of the meeting at which they are elected until the end of the meeting at which their successors are chosen.

W. W. LEGGETT,
E. R. WEEKS,
S. A. DUNCAN.

MR. MASON: I desire to make a motion, to be followed by another, and in order that the drift of my first motion may be understood, I would like to announce what the second will be, provided the first shall be adopted. I should like to move that this report be laid upon the table, in order that afterwards, if it shall be laid upon the table, I may move that a committee of five upon the revision of the constitution shall be appointed, who shall report at the next meeting of the Association. If the first motion is seconded, I wish to add a word of remark.

The motion was seconded.

MR. MASON: It is desirable, in the opinion of a number of the members of the Association, that several amendments should be made to this constitution, particularly, I might say, regarding the last article, which allows what seems to some to be rather loose action, namely, that amendments may be presented and acted upon at the same session of the Association. But without particularizing further I have made this motion in order that we may have this whole question of the

constitution brought before a competent committee who shall have time to consider the same, and report to the body after due deliberation, that we may also have time to think the matter over and act consistently and intelligently.

MR. DECAMP: I would favor the motion provided that the committee was appointed and that the consideration of this amendment was the first order of our next meeting. I think that would meet the views of a good many people here who seem to want this adopted at once.

THE PRESIDENT: Before calling for a vote on this, I beg to remind you that in my judgment amendments should only be acted upon in full meetings. You have under consideration now a matter of the greatest importance to the future success of the Association, and while I lay down the robes of authority, so far as the presidential chair is concerned, yet I expect to be around when the other fellow is in the chair, and I would like to have a full expression on all matters of this kind, and I hope that neither Mr. Mason's motions nor Mr. DeCamp's suggestion shall be allowed to pass unnoticed. I beg that you will discuss them, turn them over and over, and see how they look.

There being no discussion, a vote was taken upon the motion to lay upon the table, and the motion was carried.

THE PRESIDENT: The motion having been carried, the report of the committee will be the special order upon the first day of the reassembling of the Convention.

MR. MASON: I now move that a committee of five

be appointed by the chair on revision of the Constitution.

The motion was carried and the chair appointed as the committee, Mr. Mason, Mr. Leggett of Detroit, Mr. Phelps of New York, Mr. Stanley of Bridgeport, Connecticut, and Mr. T. C. Smith of Pittsburgh.

MR. SMITH: I beg to be excused as I am now excessively busy.

THE PRESIDENT: The gentleman can be excused. In place of Mr. T. C. Smith of Pittsburgh I will appoint Mr. Porter of Pittsburgh.

MR. DECAMP: I move that pending the adoption of the amendment to the Constitution bearing on the subject, the salary of the Secretary and Treasurer be fixed at $900 per annum.

The motion was carried.

The committee to nominate officers presented their report through Mr. Garratt, naming for President, S. A. Duncan of the Allegheny County Light Company; for First Vice-President, E. R. Weeks of The Kansas City Electric Light Company; for second Vice-President, A. J. DeCamp of the Brush Electric Light Company, Philadelphia; for executive committee, Dr. Otto A. Moses, Electrician Chairman; J. Frank Morrison, Brush Electric Light Company, Baltimore; E. T. Lynch Jr., United States Illuminating Company, New York; Frank Ridlon of the Baxter Moter Company, Boston; W. L. Strong of the Brush Illuminating Company, New York; T. C. Smith of the Keystone Electric Light Company, Pittsburgh; E. F. Peck, Citizens' Illuminating Company, Brooklyn.

The committee (to whom was also referred the place

for holding the next meeting) also recommended in their report that the next semi-annual convention be held in New York.

MR. GLAZIER: Inasmuch as time is precious and it will require considerable time, to cast an individual vote on this recommendation, I would move you that the Secretary of the Association be authorized to cast the vote of the Association on the recommendation of the committee. I understand that is constitutional.

The motion was seconded.

THE PRESIDENT: It is not competent for any member of the Association to make a motion that a ballot should be cast in any other way than that prescribed by the constitution; but, if there be no objection—that is if unanimous consent be given, then the Secretary may cast the ballot. But it is not the subject of a motion.

MR. LEGGETT: Mr. President, if you will allow me just an instant—it seems to me before voting for the Executive Committee, the question of the locality of the next meeting ought to be considered. If it should appear to the Association that it might be desirable to have this meeting at Cincinnati, then, in that event, under our practice at least, it would be desirable to have the Chairman of the Executive Committee in that vicinity.

THE PRESIDENT: I was going to say that if there be no objection, the Secretary will cast a ballot for President, and so along down, as you can only vote on one of these matters at a time. Are there any other nominations to be made than those made by the Executive Committee? There appear to be no objections

and no further nominations, Mr Secretary, so you can cast the vote.

Mr. Glazier and Mr. Jesse M. Smith of Detroit, were appointed tellers.

The Secretary then cast the ballot of the Association for Mr. S. A. Duncan for President.

THE PRESIDENT: Mr. S. A. Duncan has received the unanimous vote, and is declared President.

The Secretary cast the ballot of the Association for Mr. E. R. Weeks for first Vice-President, and for Mr. A. J. DeCamp for second Vice-President.

THE PRESIDENT: Gentlemen, I have the pleasure and honor of introducing to you your duly-elected President. He will find the office of President of this Association a pleasant one if the same courtesies shall be extended to him as have been extended to me. (Applause.)

MR. DUNCAN: Mr. President and gentlemen, I should be devoid of feeling did I not appreciate the honor you have conferred upon me, especially when I recognize the fact that I am to succeed a man who by his influence, as well as by the power of the gavel, which has been the only symbol of authority in this Association, has welded together and made the Association what it is to-day. Three years ago, in Chicago, a few representatives of electric lighting interests met and elected my predecessor, Mr Morrison, as their President. From that time on he has continued to direct and control, with the advice and assistance of the Executive Committee, this Association. It has grown in membership and influence, until to-day it represents in its membership millions of capital, and the intelli-

gence and brains of the electric light interests of this country.

I shall endeavor, gentlemen, to bring to the discharge of the duties of President of this Association, all the ability that I have, and I shall discharge those duties with fidelity to the best interests of this Association. Promise is good, but performance is better, and you will be better able to decide upon the wisdom of your choice in the future than you are to-day, and I can only thank you for the compliment you have paid me and ask your indulgence for my failures, and for probable inconsistencies in the rulings of the Chair until such time as you have proper By-Laws and Parliamentary Rules for your government. I have no doubt, gentlemen, that you will place the same confidence and trust in the integrity of the Chair in the future which you have in the past, and with your co-operation and assistance and with the aid of the retiring President, I hope and trust that this Association will do better, or as well at least, in the future, as it has done in the past.

Thanking you for your consideration I conclude by assuring you that I will endeavor to discharge the duties of the office to the best of my ability. (Applause.)

THE PRESIDENT: In relation to the selection of the material for the Executive Committee, the Convention is now prepared to take action.

MR. LEGGETT: Now I would like to hear from Mr. Foote of Cincinnati.

MR. FOOTE: On first thought it may seem a little presumptuous for me to suggest Cincinnati as the place for holding your next meeting—more so, because we

have nothing there that will either interest or instruct you in the way of mechanical or electrical plants and stations.

THE PRESIDENT: Are you speaking now to the selection of the Executive Committee, or the place of meeting?

MR. FOOTE: The place of meeting.

THE PRESIDENT: We have not got to that yet.

MR. LEGGETT: I think we do come to that in this view of the matter: We have made it the policy of the Association to select the Chairman of the Executive Committee from the place of meeting.

THE PRESIDENT: With the consent of the Convention, Mr. Foote will proceed, although speaking out of the regular order.

MR. FOOTE: For the information of the Convention, I wish to state that from the first of July until October there will be held in Cincinnati the centennial of the Ohio Valley. It is under the auspices of a commission, which first originated with a committee of citizens of Cincinnati, who have raised a guaranteed fund of a million and a quarter of dollars for expenses. Five States have, by the acts of their Legislatures, appointed commissioners to take care of the State exhibits in that Exposition. The buildings will cover about three and a half city squares. They are now well advanced toward completion; and it strikes me that it will be the best opportunity that electricians will have for a number of years to make an electrical exhibit showing the progress in electrical science and its applications. For that reason I thought it would be opportune for this Association to hold its next meeting in Cincinnati dur-

ing the Centennial Exhibition. They will be entertained by the commissioners of the Exhibition, and everything that is necessary for the convenience and business of the Association will be furnished. In addition to that, the Exposition itself will induce a large display of all appliances pertaining to electricity and its uses; and I think it would be, in a commercial point of view, quite a boom for electricity and its applied interests, to have the meeting there at that time. That is my only reason for presenting Cincinnati.

MR. LEGGETT: In that respect it seems to me that it would be a very wise move to select Cincinnati. They have at Cincinnati a very extensive display of machinery. We will have all this matter of belts and wires and machinery. These different plants will all make a good exhibit. A fine display will be made and such a display will lead all of us to compare systems together and note the distinctions between them. It seems to be eminently proper that our next meeting should be held at Cincinnati unless there is some special reason why it should go to New York. It has been held once in New York and has never been held in Cincinnati. I think the matter of the location of the place of our next meeting ought to come in at this point, in order that we may pass upon the question of who shall be chairman of the Executive Committee.

THE PRESIDENT: It has been moved and seconded that the recommendation of the committee be adopted and that the meeting be held in New York.

MR. LEGGETT: I move as a substitute that it be held at Cincinnati.

A vote being taken upon the substitute it was appar-

ently lost. A rising vote was then taken, when 14 voted for the substitute and 40 against it.

THE PRESIDENT: The substitute being lost, the question is now on the motion to adopt the recommendation of the committee. Are you ready for the question?

MR. CALLENDER: Before that motion is put I move, as an amendment, that the meeting be held at some of the summer hotels in the neighborhood of New York.

THE PRESIDENT: What hotel will you have it Mr. Callender?

MR. CALLENDER: I make a motion that the meeting be held at some place in the neighborhood of New York.

THE PRESIDENT: You better make your motion so positive as to indicate some particular location. Do you want Rockaway Beach or Coney Island?

MR. CALLENDER: I will let my motion stand as I made it.

THE PRESIDENT: Gentlemen, you have heard the amendment offered—that the meeting be held, not in New York City, but at one of the summer hotels adjacent thereto.

MR. GARRATT: That very question was brought up in the committee appointed to make a recommendation; and it was the opinion of that committee, I am pretty sure—if not, other members of the committee here will contradict me—that New York did not simply pertain to the municipality, and that it was the opinion that the convention might possibly be held near New York—at one of the watering places.

No place was discussed, but in suggesting New York we had in mind what we all call New York, which is New York with fixings. (Laughter.)

MR. MASON: Would not this include Niagara Falls, if the committee thinks that way?

THE PRESIDENT: Niagara Falls is not adjacent to New York city.

Mr. Callender's amendment was put and lost.

The recommendation of the committee that New York be the place of the next meeting was unanimously adopted.

THE PRESIDENT: We will now take up the regular order—the selection of the Executive Committee. Mr. Secretary, read the members recommended by the Nominating Committee.

THE SECRETARY (reading): Dr. Otto A. Moses, chairman; J. F. Morrison, Baltimore; Eugene T. Lynch, New York; Frank Ridlon, Boston; W. L. Strong, New York; T. C. Smith, Pittsburgh; E. F. Peck, Brooklyn.

THE PRESIDENT: The Secretary has read seven names recommended by the Nominating Committee. The constitution calls for six.

MR. DECAMP: I would suggest, without meaning any disrespect to the gentleman, that Mr. William L. Strong's name be stricken from that list, reducing the number to six. I make that amendment to the report simply because I think there is not any probability of Mr. Strong's attending to the duties of that committee. The rest are all gentlemen who are available and who will doubtless act with the committee.

Mr. DeCamp's amendment withdrawing the name of Mr. W. L. Strong was carried.

The Secretary then cast the ballot of the Association for the following named gentlemen as members of the executive committee: Dr. O. A. Moses, Chairman; Mr. J. F. Morrison, Mr. E. T. Lynch Jr., Mr. F. Ridlon, Mr. T. Carpenter Smith and M. E. F. Peck.

THE PRESIDENT: Those gentlemen are declared to be members of the executive committee, and this closes the election of officers. We will now resume discussion of the very able papers presented in the early part of the day. The discussion is on Underground Electric Light Wires.

MR. SUNNY: The statement was made this morning in the very excellent paper read by Mr. Leggett that while it was entirely practicable to work telephone and telegraph wires underground, it was not practicable to do so with electric light wires. I remember distinctly that six years ago when the question of putting wires underground in Chicago first came up, the telephone interest gathered its experts together and in meeting assembled they each and every one of them avowed with all sincerity and earnestness that while it was possible to work telegraph and electric light wires underground, it would be utterly impossible to operate telephone wires in that manner. The amount of crow that we have been compelled to eat in that time can be estimated upon when it is understood that there are 2000 miles of underground wire working in Chicago to-day. As a matter of fact, the whole electrical interest opposed the measure and left no stone unturned to defeat it. The more they fought the greater became

the general clamor for the removal of the wires. The same thing occured to which Mr. Leggett referred as having occurred in Detroit,—the statements put forth in good faith and all truthfulness by the electrical fraternity, were discredited by everybody on the other side. The authorities exercised their power in its severest form by ordering the removal of every pole and wire from the public streets within a specified time. The prohibition included the entire city of 48 to 60 square miles, acres upon acres of which are vacant; miles upon miles of the streets of which are uninjured and sparsely settled and alleys in passing through which, one instinctively holds his nose and breathes as little as possible.

The point that I think can be made is, that it is not the best policy to fight a measure in which the public seems to be so greatly interested, but to find a way to give them 10 or 15 per cent. of what they ask for, if in reason it can be done. I think now that had this course been pursued in Chicago, that we would now be able to string wires in the air outside of a limit of two or three square miles. Chicago has a thousand arc lights on underground circuits in the center of the city, the greater number of which are in the districts served by the main station, located on the Chicago river, at Market and Washington streets. Most of the lighting is east of this point, so that 25 circuits, or 50 wires, run practically together for 2,000 or 3,000 feet.

When this station was established, several months ago, a conduit of twelve creosoted wooden tubes was put down to connect with the Dorsett conduit built four years ago. The Dorsett conduit is made up of

pipes having seven ducts or holes 2 1-4 inches each. Six lead cables of 3-32" insulation, No. 6 gauge, were drawn into each duct. Lead cables were used in preference to anything else, because of the difficulties experienced in maintaining the insulation where other makes—a good many of them considered first-class—had partly or wholly failed. Many of the conductors having no lead covering have done and are doing good service in various parts of the city, but in the business portion, where the earth is saturated with water gas and sewer gas, which circulates more or less freely through the conduit, nothing but lead seems capable of withstanding their influence. The six cables in each duct were made into three circuits—three positive and negative—and this arrangement is probably responsible for some of the trouble experienced. It was found that although the insulation measurement of the lead cables in the conduit was very high—considerably above a megohm—and the insulation beyond the point where the lead cables ended, and where some other wire was used, was, say 500,000 ohms, a short circuit would form, generally within 1000 feet of the station, between the two sides of the circuit. The heat generated at the point of the short-circuiting would melt the lead in the adjacent cables, so that in one instance all six wires were rendered useless. Where this occurred in the Dorsett conduit, the destruction did not go beyond the six wires; while in the creosoted wooden tubes on another occasion, not only were the six wires destroyed, but the inflammable material of which the conduit is constructed resulted in the burning out of the entire conduit, and the sixty cables in it. The cold weather

of three months had frozen the earth to a depth of four feet; but when the street was opened it was found that the fire had taken the frost out of the earth below a foot from the surface, and that there was left for a distance of twelve feet a few charred sticks, the bare copper wires, and, in the bottom, some lumps of lead. Iron pipes were put in, and lead cables of five thirty seconds insulation used—four of which were put in each duct or iron pipe. This heavier insulation, coupled with the redistributing of the circuits, so that positive wires are grouped and kept away from negative wires, will probably result in eliminating this source of trouble.

Looking for the cause of these burn-outs it was found that they occured on circuits carrying as few as 20 lights, or 900 volts and 10 amperes and in circuits carrying 48 lights, or 2160 volts and 10 amperes. They generally occured near the station, although there was an insulation of 6–32" between the two sides of the circuit measuring considerably above a megohm, and there were weaker places beyond, indicating that the nearer the station the greater is the liability of short circuiting.

It seems incredible that the 3-32" insulation around each conductor would not carry this voltage while the same make of cable of 2–32 carries a greater voltage in another part of the city. We could not in any instance of a burn-out find that an abnormal resistance had entered the circuit beyond the place where the burn-out occurred. On the contrary as soon as the damage was repaired it was found that the circuit was in good order. Without being entirely at rest as to the exact cause of burn-outs we have adopted what might

be called a whip handle method of insulation — very heavy at the station and tapering towards the outer end of the circuit. This, it is expected, will enable the conductors to hold the current within them, under all conditions.

So much work has had to be done on the main route on account of the burn-outs that we have had to make almost constant use of the man-holes in the conduit. We find now that these man-holes are all too small, and must be increased from 3'6" diameter to 6' if possible. The suggestion is made that the latter size ought to be secured wherever possible because of the impossibility of properly putting away the labyrinth of wires and cables that must be provided for at these points.

Mr. T. C. Smith: I wish to state that our company here in Pittsburgh is probably as much interested as any company in the country in aerial wires. We have an enormous amount of pole line already set up in this city, and we are doing an immense business from that pole line, and I do not know that we should feel inclined to take the whole of that wire down and go underground within a year, or within two years. But it is very evident that the public demand is urgent that the wires be put underground wherever feasible, and our company has, without being asked by the city, and without any ordinances being passed to compel us, voluntarily undertaken to try the experiment thoroughly. We have seen a great many people try to put their wires underground, and in most of the cases which have come under my personal observation, the work has been done in such a manner that it is not a

wonder that the cables burned out. It is a wonder that they ever got current through them. As Mr. Smith, I think, of Detroit, has remarked, it is much more an economical question than an electrical one. With regard to one of the conduits of which Mr. Leggett spoke in his paper—the conduit in Chestnut street, Philadelphia—I happened at the very time that the conduit was being put down there to be connected with another company in Philadelphia which was also putting in underground conduits. The underground conduits which our company laid were nothing but a lot of tin tubes put in a wooden box filled with pitch, and we hauled into it first-class, lead-covered, insulated cables. We ran them for six or seven months without the slightest hitch and without a single burn-out. At the time that the cast-iron conduit was laid in Chestnut street it was laid without any attempt whatever to keep it water-tight or air-tight. It was nothing but an iron trough in two halves, and they made the absurd attempt to keep it air-tight by putting putty along the edges. When the cables were put in there I saw a good many being put in, and in some of the cases where lead cables were used, the ends of the cable were simply stripped for two inches of the lead, the ends twisted, and three or four turns of kerite tape put around it; yet that has been cited as a dismal failure of underground wire. Now I am not by any means arguing that all wires must go underground, for the simple reason that companies that have spent an amount of money, and have large vested interests in pole lines and wires and business, cannot be compelled, by any equity to remove the whole of that property and put it underground. In a great many cases

it would be equivalent to sending the company out of business. But I do think that companies should endeavor, in the central parts of cities, where the streets are crowded and the buildings are high, and there is no doubt that the overhead wires are a nuisance—that they should make an honest endeavor to put them underground. With first-class work, I see no reason why underground wires should not be successful. We have heard a great deal about the punching of holes through these cables. Any one who has had anything to do with arc-light machinery knows that if you take a 40-light Thomson-Houston machine, or a 60-light Brush machine, and open the circuit suddenly, you will discharge the field magnets into the line; and if there is any weak spot in the insulation, it will go through it at that instant. We have demonstrated it over and over again. I think if the gentlemen who are trying underground wires will simply shut their dynamos down regularly by either short-circuiting the armature or shunting the field circuit, that they will do away with a great deal of this punching of holes in the cables. In laying down three or four miles of lead-covered cables we cannot expect to find them perfect in every part. There will be pinholes occasionally, and the best inspection will not always discover them; but we have no right to assume, because such things as that occur, that the plan is impossible. There is not a man here present who has been in the electric business for a year who has not had a hundred cases of open circuits and short circuits on his overhead lines. The question is not whether underground wires are feasible or not, but whether we

cannot get them established with about the same trouble we took to get our overhead lines in position. I am interested in a company in Philadelphia which is running the underground system entirely. We started with a 200-volt direct current system. We knew that if we started that company the wires would have to be underground; that there were no more overhead ordinances going to be passed. We realized what we were attempting, and we resolved to spare no expense to do the thing properly. When we purchased our cables from the company—they were all lead-covered cables—we told that company to send us their most experienced men for the splicing and laying of those cables. We paid their expenses cheerfully. We not only had them make the joints, but we watched them. We started at the station and turned the current into those lines. We ran there for six months without a trace of leakage, and then we changed over to the alternating system. We put a thousand volts into those cables, and they are running to-day, and have been for nine months, without a single ground having occurred on them. We have fifteen miles of cable buried all told. We have had the question before us as to whether it would not be possible to run the alternating current in the same box with telephone and telegraph cables. At the request of Chief Walker, the city electrician, we ran in the Long Distance Telegraph Company's conduit 1500 feet of 3-conductor cable. On the two outer wires we put our alternating current, and we placed a 20-light converter in the Chief's office. Into the third wire we connected his telephone, and there is not a trace of interference on it. The telephone company, of course, had given Chief

Walker permission to put that cable in their box, but they were a little nervous about the result, being afraid it would knock out their whole system between Philadelphia and New York. After we had been running about a week they came to us and wanted to know when we were going to start up. We told them that we had been running about a week, at which they were very greatly surprised, and they have made no objection to the occupation of the box by us. Of course I have had no real experience with arc lights underground, that is high tension currents—beyond the fact that when I put down my lead cables in Pittsburgh I use a 65 light brush machine to test them with. I would not when testing them subject them to the strain of opening the circuit suddenly upon them. I do not think it would be policy to do so. Chief Walker in Philadelphia is running some four or five miles of lead covered cable on his arc circuits. He has had one or two burnouts. He had to string an air line for one section, because he could not dig up the streets, it being winter. But he did not expect to put down a perfect job the first time. There is one thing I would like to ask some questions on. It has been stated that a direct current arc light cannot go underground. I do not think that the gentlemen who make that statement fully realize what a tremendous weapon they are putting in the hands of the press against them. I am not speaking now as an alternating current man, but as a member of the Association, and as representing a lighting company which is interested in overhead wires in so far as they do not interfere seriously with public safety. We have proved beyond any question that the alternating current

can be put underground and can be put in lead covered cables without any danger of loss of current. If the direct wires cannot go underground, the alternating can. And it may be that we shall be called upon to put in a new apparatus which we do not want, simply because it cannot go underground. I think that in a case of this kind it is not the technical press we have to consider; they can realize the difficulty and danger and troubles of going underground. But it is the public press we have to consider. While they certainly do not always express public opinion they have a good deal to do with moulding it, and a persistent attack by the press on a lighting company will compel it to do what they desire. I think the sooner this question of underground wire is placed fairly the better it will be for all of us. I have had a good deal of consultation at various times with Chief Walker in Philadelphia, and he made the statement to me that some 18 months ago, before he would recommend the city to spend any money in the experiment, he wished to make a test of a certain cable, and he got a length of three hundred feet of cable. This was cut into two parts, and placed on the two poles—one on each pole of a Brush 65 light dynamo, laid in the yard of the station with the mud and water all around, and then connected with the air line. After they had run a few days a fault was developed in the cable, and there was found to be a hole punched right through the insulation. I am not sure, but I think the other connection was found at the end of the wire where it was bared to attach to the air line. The defective part was cut out and he has it in his office, and as I was under the impression that he had

been using that wire in that way ever since, I telegraphed him this morning as follows: "Is the 300 feet of cable originally laid in the yard still in daily operation?" I received the answer from him: "To the best of my knowledge it is;" and I will ask Mr. Law whether that is the case or not.

MR. LAW: That cable has not been in use for the last five months at least.

MR. SMITH: Very good. Then Chief Walker is mistaken. But at the same time he laid a good deal of cable in the upper part of the town, and that cable is still in use. Now, the statement has been made that in Chicago the average capacity of the machines was 45 lights, and the average circuits 20 lights. I do not know—but I think the man in charge of the station has shown poor judgment in dividing the circuits.

MR. SUNNY: If you will allow me, I will explain that in one word—we have put out more circuits than the present business requires.

MR. SMITH: Exactly. I presumed that you have done as I have done in Pittsburg. I have kept all my circuits the size of my smallest unit. But the fact that the circuits and machines do not agree, is no proof that it was done because the wire was defective. I would like to call on Mr. Wilber of the Jenney Company who has laid a good deal of cable in Philadelphia; I would like to ask him if his cable is in use and I would also like to ask Mr. Gwilliam to give his experience.

MR. WILBER: I would say for the information of this Association that last spring we laid over 2 miles of underground cable in Philadelphia in the grounds of Girard College. We are running 47 lights on two 25

lights machines. We have never experienced a particle of trouble with the cable from the time it was laid up to date. Where the cables came out at the top and connected with overhead wires there have been one or two grounds and leaks and lightning troubles, but no serious defect of the cable. But I am inclined to think from our experience there that there is some small grain of truth in the claim made that you cannot get as great a number of lights out of a given dynamo capacity in running underground as you can on overhead wires. With that exception I do not know that there is any serious difficulty in running arc light currents underground, unless it be that of expense, which is sometimes prohibitory.

MR. LEGGETT: How long is the longest conduit that you have in the Girard College grounds?

MR. WILBER: It is all in one circuit, sir. It is about two miles and an eighth I should judge. I do not remember the exact length. It is all one circuit, burning 47 lights on it.

MR. LEGGETT: You go out and come back through the same conduit?

MR. WILBER: Yes, sir; side by side. It is the Standard cable laid in creosoted boxes, side by side. They come back in the same box.

MR. LEGGETT: Something less than a mile in length?

MR. WILBER: The main circuit is about a mile in length. They loop out to the different towers and different places where we have lights.

MR. LAW: I would like to ask Mr. Wilber if those conduits do not pass through passage ways that go from

one building to another, and if they are not heated up to a very high degree of temperature.

MR. WILBER: I neglected to state—and it is a very important matter—that the buildings of Girard College are heated by steam and these steam pipes are carried through a brick conduit. We got the benefit of those brick conduits as far as they went from the engine room at the lower end of the grounds up to the furthest buildings. We ran through this brick conduit, laid our wires in boxes in the conduit, and then branched out underground to the towers, laying it simply underground; and the duct is always heated in winter up to a very high temperature and in summer it is not equally warm, because they have a circulation of air, by fans, etc., through the tunnel. But I do not think there is any great amount of dampness in there.

THE PRESIDENT: How much of your conduit runs in the duct?

MR. WILBER: Perhaps from two-thirds to three-fourths of the entire circuit runs in this brick duct. Those branches out to the towers run through the ground.

MR. GARRATT: May I make one motion which seems very much out of place here, but I must leave the building.

THE PRESIDENT: To what point is the motion directed?

MR. GARRATT: Thanks to the New York Electric Club for the tender of their club house. We forgot all about it. It was referred to the committee on the place of meeting and they forget it. It has just occurred to me, and I make the following motion——

THE PRESIDENT: One moment. By consent of the convention the gentleman may be permitted to introduce his motion.

The consent of the meeting was obtained.

Mr. Garratt then moved that the invitation courteously extended by Mr. H. C. Davis, President of the New York Electric Club, be declined, with the thanks of the Association.

DR. MOSES: Is it possible that my ears deceive me —that the invitation is declined?

THE PRESIDENT: The resolution is that the invitation be declined.

MR. GARRATT: I am asked why? Because I do not think the New York Electric Club House is a large enough building in which to hold a convention. I declined it with thanks. I specified the invitation as courteous. I imply no lack of courtesy to the club, or lack of kind feeling on the part of the Association, and I do not think it wise that the convention be held in the Club House.

THE PRESIDENT: My recollection of Mr. Davis' telegram is not that it invited the convention to meet in Club House, but simply offered the Association the courtesies of the club.

MR. GARRATT: That being so, may I withdraw my motion, Mr. President?

THE PRESIDENT: With a great deal of pleasure. The Secretary gave the dispatch to the committee. The dispatch read in substance that they urged on the Association the selection of New York as the place of meeting, and offered the Association the use of the Club House while the convention was in session.

MR. GARRATT: May I substitute in my motion the word "accepted" in the place of "declined?" It is but a slight difference. (Laughter.)

MR. CANDEE: Your interpretation of that telegram is the correct one. The Club House would not be anywhere near large enough to accommodate the Association, and it was the intention of Mr. Davis to give the convention the same liberties as the members have during the convention week.

THE PRESIDENT: With the consent of the convention the gentleman will be permitted to make that amendment; substituting the word accepted in the place of declined.

Mr. Garratt's resolution as amended was adopted.

THE PRESIDENT: I suggest that some gentleman make a motion that the resolution offered by Mr. Garratt be transmitted to President Davis of the New York Electric Club by the Secretary.

MR. DECAMP: I make that motion, Mr. President.

The motion was carried.

MR. KINSMAN: There is one thing that has not been referred to in connection with this underground matter, which seems to give a great deal of trouble; that is static induction; atmospheric electricity. I would like to have some one give his experience on that.

MR. DECAMP: Two papers have been read to-day on this subject of underground conductors—one for, and the other against; but there is one thing in which they both agree—perhaps two, but one in particular, and that is that we must have a perfect insulation. The second is that it is only a matter of cost. Now I believe that the first one is true, and no station will be operating

a complete underground system until they secure that perfect insulation. In regard to the point that it is a question of cost, I think that ought to be left out until some gentleman is prepared to say just what that cost will be—not that it is only a matter of cost; that is keeping the companies from doing it, even keeping them from making a fair, proper and unbiased test. The question of cost is certainly one of very great importance. Electric lighting from central stations is now nine years old. There are organizations who have back of them probably as good business talent as ever backed up any new enterprise, and as a rule they have been organized for business purposes. They are officered and controlled by men who do not hesitate to invest their money in things that they think will ultimately pay—not to get their money back, because if that was the case, they have been, without exception, I guess, grievously disappointed. They are waiting for their dividends yet. All know—if they do not they can find out very easily—that the returns upon the capital invested in electric lighting have not been large. They have not been such that would justify the investment of money in a business which is likely to undergo rapid changes or rapid improvements, carrying with them a large depreciation in the value of their property. But the business which they are doing to-day is established—the prices are established upon the basis of the cost of their present plants, and it is unnecessary to say that it would be utterly impossible for any company to go before the public to-day and advance the price of their lights. The prices of electric lights are high; they always have

been; they are high to-day. They are lower than they were when they were started; but they are high to-day; and that is the view that every consumer takes of it Therefore you cannot advance your price. The cost of an underground conductor—those that are said to be entirely reliable to-day is four or five times as great as that of the ærial wires which we are using and using successfully. Now in addition to that you have got to add the difference in cost in putting those wires down. It will run the cost of your construction up to an enormous amount. That has all got to be provided for. I will anticipate what has been said, and I presume will be repeated, that after you have done that your expenses cease practically. That I do not believe from our own experience. I would not venture to say that until I had had a long experience in it. I do not believe it is the case.

In regard to the lead-cased cables—I cannot give the reasons for it—there has been a tendency to short circuit between the wire and the lead. That shows of itself an imperfect insulation. Your lead is no insulator; it is a protector, and it does not protect when your insulation is imperfect. We do not have those troubles with overhead wires. I will state in brief the conditions of the underground wires referred to by Mr. Walker, and I will leave it without any comments as to whether that is a demonstration. I will only go back to the point where I have had the general management of the company that is operating those wires. We start from the station and reach the first terminal of the conduit—I will give the figures—3375 feet of single ærial wire from station to entrance of conduit. Thence

by 1412 feet of single wire one side of the circuit from the open conduit; thence through the conduit 9500 feet, making a loop of 19,000 feet of lead-cased cable placed in a box 6 inches square and filled in solid with pitch. Thence by 30,500 feet of overhead wire, one side of the circuit to the station, making a circuit of something less than eight miles, of which about four and a half miles is underground and part of which is one side of the circuit only. The upper section of that circuit is put in first. About half of this 9,500 feet was filled in solid lead—cased cable, and I agreed with Mr. Walker at the time that was put in that it was the best I knew of—although I did not know anything about it—it was well made. That cable gave out once. The defect was in the lamp-post, but it was a short circuit between the cable itself and the lead. It was put into the lamp-post carefully, and there was no particular reason why it should be there so far as anybody could find out. Afterwards a defect in the circuit occurred underground. It being winter time and the ground being frozen, he strung the wire from one lamp post to another. There has been since then one defect of the same kind which has been removed. There is another one that has been cut out all winter between lamp posts for the same reason; that is, not on the poles; it is underground. More recently there is another section between poles cut out in that part of the circuit in the open duct, with one side of the circuit only. In addition to that we have had what did not concern me, notwithstanding our experience in the Chestnut Street conduit; that is, a comparatively new section of the city—at least, the gas mains are comparatively new,

Down in the lower part of the city the gas mains are very old and very defective, but in this part of the city the conduits were comparatively new, and the leakage of the gas was not supposed to be to a degree that would be likely to interfere with the conduit.

There have been three explosions in those man-holes within the last three months. I was favored with being on the spot when one of them occurred. It was in the first man-hole where the wire came off the poles and into the side of the man-hole entering the duct. When that man-hole was blown off it was broken in three pieces. The cover weighed about 400 or 500 pounds, I think. In the bottom of the man hole were three or four inches of water. I happened to notice a little spattering of solder in the water. The man put his hand right under the lead and he found a small hole where the current had gone through and melted the lead. There was no contact there at all. It came clean out of the man-hole and went into the duct. Those are troubles that are purely, in my judgment, incidental to the conduit, but there has been other trouble which I think will always exist with lead-cased wire, while it might not with some insulated cable without the lead. That is the difficulty of getting your low terminals safe at the lamp terminal. However, that difficulty would be overcome in some way or other. But it is the question of underground wires themselves. That is the history in this short time of that effort—that is, about eight miles. I just submit whether any company would want to enter into the task of putting down 100 to 150 miles on the strength of that experience—whether they would take the risk of pronouncing that

sufficiently successful for entering into a general system. For my part I would not. It would not take me long to decide that. In regard to the Chestnut Street conduit which Mr. Smith referred to, that is an iron conduit, and my objection to iron conduits would be pretty much the same as it would be to any lead or any metallic casing outside of the insulation itself. I think the effect would be very likely to be the same. But there is no getting away from the fact that as a structure for the convenient handling of wires the Chestnut Street conduit is as good if not the best that has ever been brought to my attention. It is certainly a very convenient thing. It is a very expensive thing. As to being well laid, I doubt whether it was; but within the last year that conduit has been nearly reconstructed from one end to the other. It certainly has from Seventh Street to Broad. It has been dug up and taken out and relaid, and the reason it has not been constructed below that is that we have had a pile of brick on top of it so that we could not get at it. A blower is constantly kept going to keep that free from gas. The ventilation we have given to it by making connections between the conduit and the iron lamp posts open at the top, has only been a partial remedy. I telegraphed Mr. Walter F. Smith, Superintendent of that station, to be here. I think I am safe in saying that he has had as much, if not more experience, in the putting wires underground and the handling of underground wires as any one. In fact that is his education. He has done very little outside of that. He has been indentified with those conduits almost ever since they were started. He is a man of above ordinary intelligence. He is an

electrician. He is a level-headed man. And what he does and has done since he has been managing that station he has done thoroughly and well. Therefore I infer that the work which he has done there has been done as well as anybody can do it. He has made mistakes. He feels that wires can be put underground, but he strikes that snag of expense. He is not prepared to say it could be done at the price at which any company could afford to do it. We had that station and it was an elephant on our hands. It was not paying, but there was a certain expense which we were subject to whether that station was running or not. We were running 125 arc lights from that station and we needed the income from them. After the last explosion, notwithstanding the fact that Mr. Smith thought that the system of ventilating that conduit by a blower was a safe one—we had this last explosion—fortunately the first one that ever did any damage to an extent that we had a claim brought against us; and after giving the thing proper consideration I came to the conclusion that the company could not afford to run that station and take the risk of having to pay such damages either to property or to life, and we abandoned it and have converted it into a small incandescent station. Now in that station we are using a current of 120 volts I think, and it is true with that current we have had no trouble. Our circuits are short and we have put in the best wire we knew how. In regard to the other explosions which occurred in there, there were seven of them, arising out of the leakage of illuminating gas—I believe it is generally admitted by the committee appointed by the University to investigate it, that it was illuminating gas

and not an admixture of illuminating and sewer gas, and that the explosion was caused by the short circuiting of the wire. Mr. Smith has had some bad wire in there, and he has had some very good wire in there. Now here is another thing that we ought not to overlook—that the prices will not be increased, at least, and that there is a much greater prospect of having to decrease them. With the scale of expenses brought as low as we have been able to bring them with six or seven years' experience to reveal to us our defects and deficiencies in administration, we start out to increase the cost of our construction without being able to get any compensation for it. The only off-set that we have got to that is to save in the mileage of our wire, and it is just exactly what Mr. Smith is doing in making his circuits out to correspond to the smallest machine. Now we will double up our circuits and we will double up our machines, or we will make our circuits longer and double our voltage. That is the only one off-set that I can see to compensate us for this enormous increase in expense. We have not only got to provide for that 2,500 or 3,000 volts which we are using now, but we have got to provide for double or treble that, and I am sure that if this was an experiment which would cost a trifling sum that would be one thing, but here is an experiment you cannot make except at a very great cost. I have had correspondence—not knowing that Mr. Leggett had had correspondence to the same purpose—and the statements that I get are almost identical with his own.

Mr. T. C. Smith: In speaking of the conduit on Chestnut Street, I was perfectly aware of the circum-

stances under which the Brush Company took hold of that conduit – that it was work put down before they got hold of it. Mr. DeCamp did not make it quite clear—he seemed to think that I did not consider Mr. Walter F. Smith a competent man. My best answer is that I am using the apparatus which he uses, for putting in the conduit herein Pittsburgh. I think it is because a reliable and conscientious man did the work that your incandescent lights are running as satisfactorily as they are. If the work that he has done on the low tension cables has been no better than the work done on the old cables they would have given you the same trouble. I do not think that two or three burn-outs on the first cable ever laid has anything to do with the question of success of underground conduits. It is purely a question of policy for the companies. I do not believe there is a company that has a system of overhead wiring that could put a whole system underground without going into bankruptcy. The main question is can they not make some endeavor to put the central part of their wiring in the central part of the city—underground, and by and by I think that they will cut off a great deal of this public opposition to their wires. In Philadelphia, ordinances have been passed allowing overhead wires to be put in the suburbs, but on the main graded streets of the city I think the electric light companies will find their best policy to put some of their wires underground.

THE PRESIDENT: I have a resolution here which Mr. Duncan has asked me to present to the association —a resolution appointing a committee of three on transportation.

MR. DUNCAN: I desire to make a suggestion in connection with this. Some trouble arose in regard to the certificates of some of the members of this Association on account of the delay on the part of the Trunk Line Association in acting upon the recommendations and suggestions of the Executive Committee. In an interview yesterday with the Pennsylvania Railroad officials I ascertained the fact that Pittsburgh was the dividing point between the Traffic Association and the Trunk Line Association, and in order that this matter might be brought to a close properly, and that this Association in the future might obtain suitable rates for transportation promptly, and that there might be no disturbance or misunderstanding in regard thereto, Mr. Watt suggested that if a Committee on Transportation was appointed at this convention, and should take the matter up promptly, that this whole matter could be arranged between the Trunk Line Association and the Traffic Association in such a way that the rates could be secured within three or four weeks, and published and made good for the convention in August. Therefore, I offer the resolution which is in the hands of the Chairman that a committee of three on transportation be appointed, one in Pittsburgh, one in New York City, and one in Chicago, or adjacent thereto, dividing the country up into districts from which we can reach the railroad centres easily.

THE PRESIDENT: Gentlemen, you have heard the resolution. All those in favor of its adoption will say aye?

The resolution was adopted.

THE PRESIDENT: I will appoint on that committee Mr. T. Carpenter Smith, of Pittsburgh; Mr. Geo. F.

Porter, of New York and Mr. Geo. S. Bowen, of Elgin, Illinois.

DR. MOSES: May I request the liberty of interrupting the debate for the purpose of introducing a resolution?

THE PRESIDENT: If there be no objection the resolution can be presented.

DR. MOSES: I have drafted resolutions which I know will meet with the unanimous approval on the part of the convention. I will make no preamble, because you all have in your minds whatever I would say on the subject. I will simply read the resolution:

WHEREAS, It has pleased Mr. J. Frank Morrison, to insist upon not being re-elected to the position of President of the National Electric Association which he has continuously held since its organization; and

WHEREAS, We have tacitly agreed at our successive re-elections of him to allow him to retire (as he has invariably requested at each meeting) whenever the interests of the Association would not suffer by such action; therefore, be it

Resolved, That we, the National Electric Light Association of America, representing in our midst every department of electric light and power industry, express our deep regret at the decision of Mr. Morrison not to allow us to keep him at the helm, where, through many storms and quicksands, through much fair weather and some foul, he has successfully guided us to the haven where we now find ourselves; and be it further

Resolved, That a vote of thanks be given Mr. Morrison for the disinterested devotion, enthusiasm and steadiness with which he has administered the affairs and presided over the proceedings of our conventions; and that further we tender him our best wishes for his deserved enjoyment through a long and prosperous life, of the beautiful prospect of the great work he has done

in founding, fostering and cherishing the National Electric Association. (Prolonged applause.)

MR. DUNCAN: In rising to second that motion I desire just to make one remark, which might probably have been better made at an earlier stage of the proceedings of this Association. There has been a criticism made in regard to our President which to my mind was absolutely unjust and unfair, and I cannot omit at this time to bring it to the attention of the Association as one of the facts which influenced Mr. Morrison in absolutely declining a further re-election to the office of President of this Association; he having engaged in another business—the motor business—and it seemed to him that his action as President of this Association, in the appointment of committees and in other ways might be construed, in some way, as being influenced in some measure by his own personal interests. I say having thought that his official action might be construed in that way he utterly and absolutely, in a conversation with me, refused to be present at this meeting unless he was assured that some steps should be taken for the election of a successor. I endeavored to reason the matter with him, both by verbal and written communication, but without any result. I simply mention this matter now to show that the best interests of this Association have in his hands always been protected, and that while the considerations I mentioned to you have influenced him to a large extent to the final and decided step which prevented him from further continuing his services in this Association, they also resulted in the recommendation which was made to this convention some time since. In rising to second

this resolution I want at the same time to say that so far as my own preference is concerned and so far as my wishes for the well being of the Association are concerned, I should have desired to have him remain at the head of this Association, but this seemed to be a stumbling block in his way, and I simply mentioned it so that the Association can see how the matter stands. I second the resolution, Mr. President. (Applause.)

MR. LEGGETT: (In the chair.) I desire to say that I think I have been twice placed upon this committee, once at Boston, and once here at Pittsburgh, relative to this change in the Constitution, and that this was suggested to me in the same manner in which it has been suggested to Mr. Duncan by Mr. Morrison himself at Baltimore, and my zeal in the matter has grown out of his own desire to be relieved from that embarrassment.

Is there anything else to be said on the motion?

MR. MARTIN: I would like to support the motion by proposing that as Mr. Morrison has given the Association three years, the least that we can do is to give him three cheers. I therefore propose three cheers for Mr. J. Frank Morrison as President of this Association.

The cheers were given.

The resolutions proposed by Dr. Moses were unanimously carried.

MR. MARTIN: I would like to offer a resolution in connection with what has just been passed, before any further business be taken up. The resolution is as follows:

Resolved, That the resolutions adopted in regard to the invaluable services of J. F. Morrison as President

for three years, be suitably engrossed and given to him, and that a committee be appointed to carry out this work and to make the presentation.

The resolution was seconded by Mr. Duncan and carried.

MR. DUNCAN: Before any further business is taken up I desire to move that the thanks of this Association be tendered to the telephone company of this city, of which Mr. Metzger is the manager, for the courtesy extended to this Association by placing a telephone at its disposal in the Executive Committee's room.

The resolution was carried.

THE CHAIRMAN: The Chair will appoint on the committee provided for in Mr. Martin's resolution, Mr. Martin and Dr. Moses.

THE CHAIRMAN: This matter of underground wire is open for further discussion.

A dispatch has been received from Mr. Arthur Steuart from Washington as follows: "Met the Committee to-day. They are favorable to our plan."

MR. WRIGHT: As representing a company which operates an alternating system, conveying it underground, I would like to make one or two remarks. It seems to me that the matter of underground work has got to be considered. The public will force us to face it. We do not intend to stand just where we are in electric lighting. Electric lighting has come not only to stay, but to increase, and if we wish to do a larger business we have got to do a general business, and in a general business we will be compelled to place our wire underground, I think. However, I will simply state to you, gentlemen, that I have now been operating for some

time an underground system. It is not very extensive, and it has not been operating for a great length of time —some four months, but during that period, and possibly during the worst part of the year—during the fall of the year, when we are troubled with water in our conduits and man-holes, we have had no trouble whatever in that conduit, and the only occasions on which I have had to open man-holes for the purpose of getting to my conduit were due to outside causes. Our buildings are connected directly at the man-holes and junction boxes, and on two occasions, when my men were connecting converters, they short circuited and blew out the safety fuse, and on those occasions only we opened the conduit. When I left Springfield we had fifteen inches of packed snow on the streets. Our company do not pretend that they were doing a big thing in doing the underground work. It was simply because they were compelled to. We have no poles there. All our arc wires are on structures on the buildings. It was impossible for us to do any work there unless we went underground. I think it will be found in the next year or two that a very large number of companies in this country will be placed in exactly the same position, and that being so we must all look to the future, and try and learn all we can about underground work. My advice to our company would have been to wait and let other people experiment, had we not been compelled to go underground. However, we are running underground. The work is not costing a great deal of money, and I do not expect that we will have a great deal of trouble. I simply state that we are doing this, as a proof that it can be done, for a short time

at all events, and if it can be done for a short time it can be done for a long time.

THE CHAIRMAN: You say you have no arc light lines underground?

MR. WRIGHT: I have one arc light line underground, but not connected.

MR. EUSTIS: I would like to ask Mr. DeCamp whether there has been any trouble in Philadelphia from depression of the ground causing chafting of the cables—a matter that has occurred to my own knowledge in underground work.

MR. DECAMP: I am very sorry that Mr. Smith is not here; he could answer that question, but I will say that I do not believe that anything of that kind has been discovered or realized to any serious extent, because I think he would have mentioned it. On the contrary he has frequently made the statement to me that some wires which we have displaced that were occupying a convenient duct in the conduit came out to all appearance as good as they were when put in.

MR. EUSTIS: I would like also to bring up that other matter that has been referred to, and that is in regard to the static charge or discharge whereby the insulation of the cables is ruptured. Now in the matter of a lead-covered cable, we have there the best conditions, of course, of a condenser—that is the inside conducting wire, the insulating material and the outside lead covering in close connection. Now if a static charge takes place, the cable itself being a condenser, the longer it is and the better the insulation of the cable, the better the condenser, until you would get a very heavy charge its total length. If there happens

to be one weak spot in it the whole force would be expended on breaking it at once. A number of gentlemen have spoken to me with regard to the puncturing by the discharge—that it always discharges directly through the lead. With a mass of lead around the outside, we would naturally suppose that the electricity would travel along the lead rather than directly through it, because oftentimes the lead is not in direct connection with the ground at that particular point. Now the question comes here, does it go through? Is it true that the static charge has a persistence in one particular direction rather than following the line of greater conductivity? I for one should like to hear from those who have had experience in that direction.

MR. LOCKWOOD: I would like to ask the gentleman who has just taken his seat whether the result described was not brought about by the fact of the heat evolved at that point, by the connection having melted, the lead leaving a bare space not covered and having simply given the appearance of the electricity having passed through.

MR. EUSTIS: That is a point I cannot answer. The thing was simply mentioned to me. As I understand it, however, the same thing has occurred in iron pipes where the wires were laid in a mass of insulating material, that the same rupture has taken place, forming as it were, a very small hole directly through the iron pipe—burning it out, and at the same time that that was done, it did not seem to be due to the fact of poor insulation, so to speak, at that one particular point. It seemed to me more due to a static charge. I have also heard it stated that this usually occurs where the under-

ground system is used in connection with overhead, not where an underground system is used exclusively.

MR. PHELPS: I wish to move, if you please, that the hour of five be appointed for the hour of adjournment of this convention.

The motion was carried.

MR. DECAMP: I would like the privilege of offering the following resolutions:

WHEREAS, In the death of Mr. W. S. Frear, Secretary of the Brush Company of Buffalo, N. Y., the Association has sustained a severe loss,

Resolved, That the Association hereby expresses its deep regret at being deprived of the fellowship and counsel of so young, promising and active a member, and that it further hereby tenders its sincere condolence to the many friends and the family of the deceased.

Resolved, That the Secretary make the communication of the above to those who have been thus sorely bereaved.

The resolutions were seconded by Mr. Martin and adopted.

MR. GUILLIAM: This question as to the condensation on underground cables I think can be answered. I am not an electrician; I am a civil engineer and I have had quite a large experience in laying underground cables. We have personal supervision of all the cables laid by the Keystone Light and Power Company of Philadelphia, and personal supervision of the making of their connections and joints. That, I think, is where the difficulty has originated in the past—bad connections. We have put down lines of double conductor cables for the alternating system that only have a covering of lead over the whole of it. They have run

successfully for nine months without the slightest trouble from them. I think if the question of condensation occurred it would occur in there where the two wires were so closely together.

MR. LOCKWOOD: In regard to the conductors used by the companies doing lighting in London, while I was there during the years 1881 and 1882, I had been informed, I stated this morning, that they were twice or three times renewed, and that I thought at that time they were using the best cables manufactured. The cables used by the Anglo-American Brush Company of London were manufactured by the India Rubber and Gutta Percha Telegraph Cable Company, Limited, of London. After the first two burn-outs I do not think it stands to reason that they would put in a third cable of an inferior quality; and if, as Prof. Forbes said, the first two cables were gutta percha, while the quality they now consider the best insulator is India rubber, I think that this firm would have put in whatever they considered the best, and my information I obtained from the President of that company while ordering cable from him for our own company. He told me they had twice removed the other company's cables. He said: "We are now supplying a third cable to do their work, and we hope this cable will do the work." And it was to find out whether the last had successfully accomplished this result that I put the question this morning to Prof. Forbes.

In regard to our work in Detroit I would say that we have there the Dorsett conduit, laid before I went to that city, and the Thomson-Houston wires. The majority of the wires—four-fifths probably, were thirteen

months ago laid in that conduit. They were the Callender wire. We had from the outset of my connection with that company troubles with these wires. We had them largely from single grounds. They were never absent. But I do not think grounds on circuits resulting in a partial short circuiting of the circuit were difficulties that we had very frequently. One night I especially remember, before either end of the circuit entered the conduit, we had the central portion of the circuit cut out, so that the lights on that portion were simply red. The lights on the end portions where the wires were overhead were to their full brilliancy. We found on investigation that one of the troubles was water within the conduits, and that was something, I found, from which they were never free. The other trouble in this case was in one of the iron pipes leading out of the conduit to one of the buildings in which we had lights. Now we had during my connection there a great many troubles of that kind, and we had them so frequently that we gradually substituted aerial wires for underground wires. Our trouble now, compared with what we used to have when the wires were underground, is, comparatively speaking, nothing.

Mr. Smith, of Detroit: We have heard a great deal about the number of accidents that have occurred in underground conductors. Now if we are to condemn a system of underground conductors by the accidents, what becomes of the whole electric lighting system? The whole history of electric lighting, and in fact the whole history of any industry is built up on the experience of accidents and failures. We have heard a great deal about the failures; we have not

heard a great deal about the successes. We know that incandescent lights are doing good work to-day. What were they doing five years ago? What were arc lights doing five years ago? We have an arc light to-day which is steady; a man can read by it. He could not read by an arc light five years ago. We have incandescent lights to-day that will last for 1000 hours and consume 50 watts of energy. What could we have done even a year ago in that respect? So far as any advancement is to be made in any branch of electric lighting, it must be done by profiting by the good experience as well as by the bad experience of the past.

Now in regard to the shunting off of the current and discharging the field magnets into the wires, that certainly throws an immense strain on any system, and the discharge of static electricity does exactly the same thing as the water-hammer in water distribution. You set a faucet running and then turn it off quickly and you have the whole system jarring and trembling, and oftentimes breaks are made in that way. There is no difficulty in overcoming it, because we have found out how to do it; so we will find out how to prevent static discharges, and discharges from field magnets or dynamos, from puncturing the insulation.

In regard to the Girard College installation we have learned that part was put into hot conduits; part of it is laid in common wooden pipes under the ground. Sometimes it is exceedingly hot and sometimes it is cooled in summer by the circulation of air. That only proves to me, gentlemen, that the underground system is, if properly put in, able to withstand all these

difficulties, and the only trouble that is cited in connection with the Girard College plant was a leakage at the joint, and there comes the question again as I said, and I think I will not be contradicted, that 90 per cent. of all the failures that have taken place in underground conductors, or any kind of conductors, have been at the joints. The question has been raised about short circuits between the conductor and the lead. Certainly when the lead conductor is laid in the wet ground, the lead is a conductor and the ground is a conductor. Why is the lead any worse than the ground? The ground is generally considered a pretty good conductor. The telephone and telegraph people use it for their returns entirely, and they use it because they do not get any resistance. Therefore it is the best conductor they can get. I pretend to say that the lead casing on the outside of a thoroughly insulated conductor is no worse than a thoroughly insulated conductor laid directly in water or directly in damp ground. We have heard about the short circuits from the line to the case. I suppose some persons have heard of short circuits between telephone wires and district telegraph wires. We have heard about lead covered cable being a failure in a great number of places. In certain places it is prohibited by the Underwriters. Such cable I have seen a great deal of. I have seen quite a good deal of it where the lead casing was barely 1–64 of an inch thick, and was nailed up very securely to a brick wall with double pointed tacks. That is one way of putting it up. One way of making joints in such conductors is to strip the joints, twist the wire together and let it go at that—sometimes put a little

tape on, but that is not always considered necessary. So it is with the iron casing. An iron casing is a conductor just the same as lead. The ground is just as good a conductor as either of them. And I take the position that when a conductor is put into a duct that just as good insulation should be used when it is put into the duct as if it were laid directly in the ground or directly in the water; and I also take the position that a lead covering or an iron covering or a tape covering, or whatever protection is put on the outside of the insulation, is simply put there for mechanical protection; that the insulation must be between the mechanical protection and the conductor, and must be put on in such a way that the conductor cannot eventually melt down through the insulator and come in contact with the casing. Now it seems to me that there are certainly a number of thoroughly good insulations that have been tried that would work all right, if they are properly put on with textile fabrics, such as tape or braid, so that the insulation can be held on to the conductor, and then, after it is thoroughly held on and thoroughly insulated, that the whole thing shall have a casing of some kind, whether lead or iron or what not—simply a casing on the outside of all of it, that shall be a mechanical protection. This sounds like a very expensive cable. It certainly is. But is it a greater expense, for the amount of light and for the return given, than the gas mains of a large city? Do not the gas companies invest twice as much capital for the amount of lighting as is invested in any electric light station in this country?

MR. DECAMP: I do not want to go on the record as opposing the underground system to the extent of

making no effort for its ultimate accomplishment. But all that Mr. Smith says and all that people say here comes right back to that one thing—a perfect insulation. Now that is what I claim we have not yet discovered. Where you put it underground you put it out of your reach. It is not like where you have a wire overhead where you can go right to the imperfections and correct them. I do not mean to say that we are not subject to those annoyances of grounds and crosses on overhead wire, but we can go and remove them. We cannot where our wires are underground. When they once come they do not get any better. They always grow worse. In regard to the cost of it, we are comparing it with things that are in existence. We cannot make the comparison fairly until we know what this is going to cost. But guessing at it, and looking at it from a business standpoint, comparing it with the gas mains—if we could put a wire underground which we could make earn money every hour in the twenty-four and every minute in that hour, then we could afford the expense of putting on an insulation; we could afford almost anything. But what is the case? Some of our circuits earn money two hours in the day—three, four or five hours in the day. But they cost the same as if we were working them all the time. The product of that wire is limited to the number of lights your machine will produce; that is all. You have reached your limit. You cannot do anything more about it. Comparison is sometimes made with the telegraph business. I do not know anything about that; but I have understood that the amount of business to be done over a telegraph wire is limited to the number of minutes they

can use that during the day. We cannot do this with arc light wires. We shall not be able to do it at any time. Hence you cannot draw a comparison between gas and electric light companies on that point.

On the question of the cable mentioned by Prof. Forbes this morning, I would say, that my recollection is that I corresponded with the general manager of the company in 1882, as to what was being done then, and I have that letter somewhere on file which says that it is the India Rubber and Gutta Percha Company—a long title—but the popular company for making those cables.

MR. T. C. SMITH: If the alternating system had been let go because a year ago at the convention we were shown some pretty experiments to demonstrate that converters would burn out three weeks after they had been put up, there would be 100,000 less incandescent lamps in the country to-day. If we are to abandon experiments to put our wires underground, because a large number of the attempts to do so have been failures, we had better go out of the business.

MR. DECAMP: I do not recall to mind a single one of our troubles with underground wires.

MR. LAW: We never have had a joint give out.

MR. WRIGHT: Then you must have a perfect insulation around your joints.

MR. SMITH of Detroit: I do not know but that I made the statement that the faults were directly at the joints. I think they are directly traceable to the joints. If a lead covered casing or any other kind of a casing is brought up to the surface and simply the lead casing taken off, the insulation exposed and taken off also for a part, and the wire exposed and a connection made on

to it to go to an aerial line, and the insulation is left so that it can absorb moisture, it will gradually creep in between the insulation and the casing, and you don't know where it is going. It may go in a foot or it may go in ten or 12 feet. The fault will come wherever the moisture strikes a flaw in the insulation.

In regard to the earning properties of a gas pipe, and the earning properties of an electric light wire, it seems to me they are entirely similar. You have got wire in one case and pipe in the other. You have got the potential in it. If you do not get it out it is your own fault.

MR. LEGGETT: In a gas pipe you can count in getting your gas. With the other you cannot count on getting your electricity.

MR. SMITH, of Detroit: I do not see that, sir. There are faults in gas mains. You often see the streets dug up in the winter time to put a sleeve on a broken joint. I think you will find the streets dug up as many time for gas and water pipes as for electric lights, counting the same number of feet of wire or pipe.

MR. DECAMP: At the same time anybody can see the conditions will be similar when we reach a storage battery corresponding to a gas holder. There is where our trouble comes.

MR. T. C. SMITH: The best storage battery, Mr. Decamp, is a spare dynamo. (Applause.)

THE CHAIRMAN: The hour of adjournment has arrived. I expected Mr. Morrison here to adjourn the meeting, but he sends word that he cannot come. I therefore declare the meeting adjourned *sine die*.

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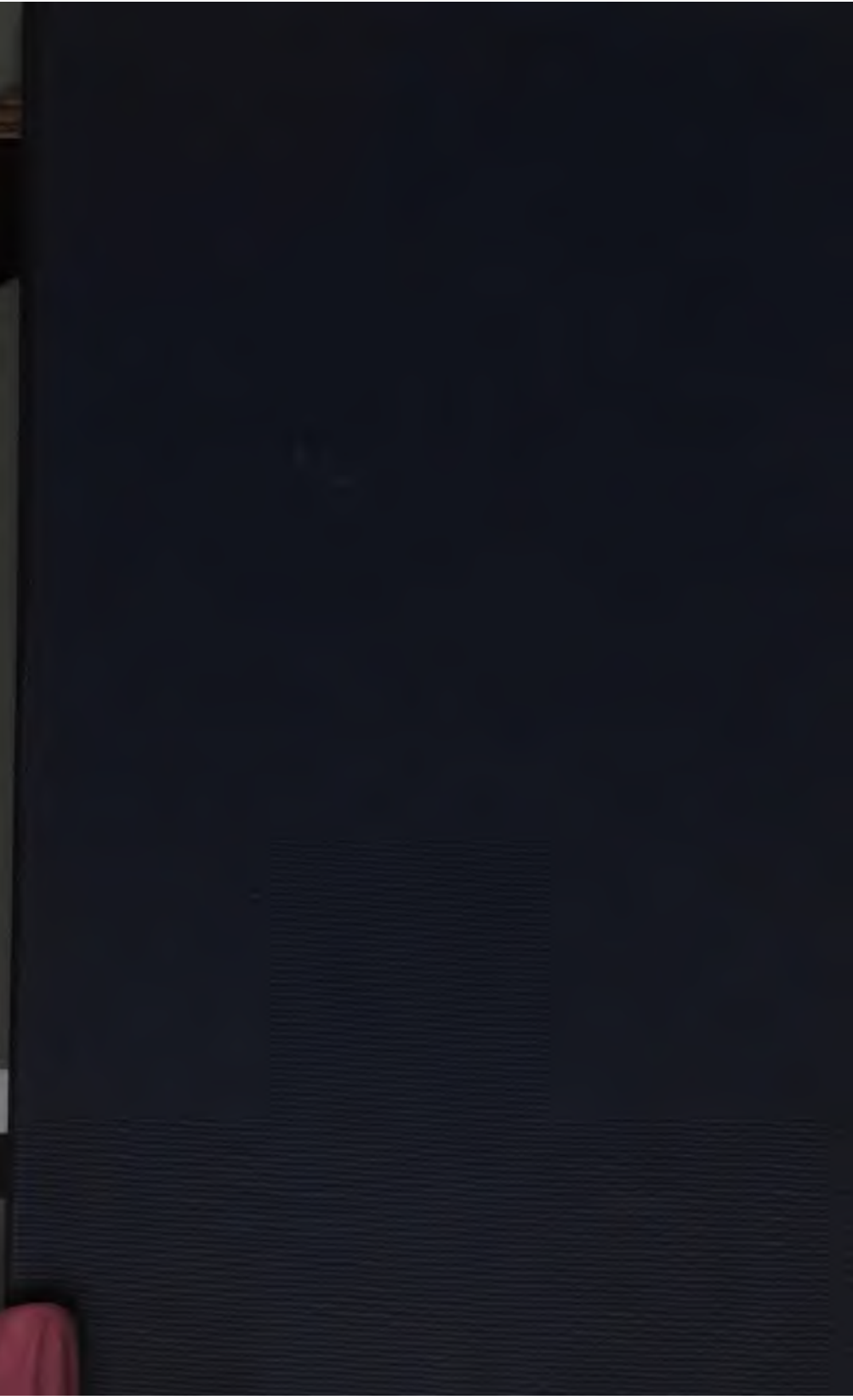
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